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THE DETECTION OF OIL FILMS BETWEEN HYPOID GEAR TEETH USING CONTACT RESISTANCE MEASUREMENTS *

By R. B. CAMPBELL † and D. MACDONALD †

SUMMARY

Experiments have been carried out to explore some of the variables affecting the lubrication between hypoid gear teeth, using contact resistance techniques. The measurements indicated the presence of appreciable oil films during at least part of the meshing cycle under the speeds, loads, and temperatures corresponding to the usual full-scale axle test conditions, except at very low speeds and high loads. The oil films were always very thin or absent where the sliding speed, and consequently the gear surface temperature, was highest. The effect of surface conditioning of the teeth through " running-in " has been investigated, and suggestions are put forward as to the role of so-called extreme pressure additives.

INTRODUCTION

IF hypoid gears are lubricated with a " straight " mineral oil, surface damage of the teeth, known as scuffing, frequently results. This damage can be avoided by the addition to the mineral oil of compounds containing sulphur, phosphorus, and chlorine, individually or together. The compounds react chemically with the metal of the gears to form surface films which provide protection and lubrication.

The development of methods for evaluating such extreme pressure (EP) gear oils requires better knowledge of the mating conditions of hypoid gear teeth and the conditions of lubrication between the teeth.[1] Unfortunately, there is still a great deal of uncertainty as to the conditions of lubrication which obtain between the teeth of gears in general. Operational loads for hypoid gears are such that for a long time it seemed unlikely, on the basis of conventional theory, that hydrodynamic lubrication was possible; on the other hand, appreciable loads have been carried without surface distress even when lubrication was by straight mineral oils which have poor EP lubricating properties. Conventional analysis of the problem does not take into account the fact that the hydrodynamic range of operation might be greatly extended by elastic distortion of the contacting surfaces[2] and by the increased viscosity of lubricants under high pressures.[3] It seemed of interest to determine whether or not these phenomena were sufficient to enable hypoid gears to run under substantially hydrodynamic conditions. The object of the present work has been to establish whether the lubrication between the teeth of hypoid gears was to any extent hydrodynamic, and if so to explore the effect of variations in operating conditions on the degree of hydrodynamic lubrication. Effort has been directed mainly at the detection of the presence or absence of appreciable oil films by measuring the contact resistance between the teeth, and no attempt has been made to estimate absolute values for oil film thicknesses.

APPARATUS

The experiments were made using the National Engineering Laboratory axle rig. This is of the power circulating type, with locked differential, and is illustrated diagrammatically in Fig 1. The maximum

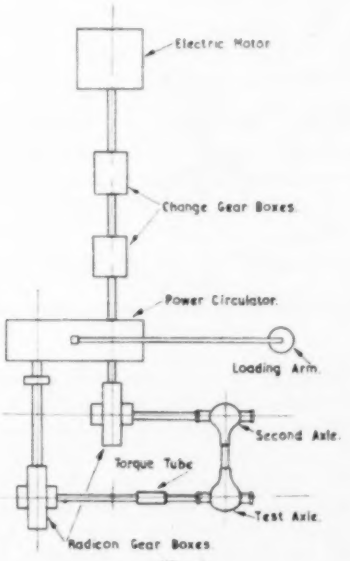

FIG 1

DIAGRAM OF THE POWER CIRCULATING REAR AXLE RIG

permissible power circulation under steady conditions is 100 hp over speeds from 200 to 1000 rev/min of the axle, with a limit on ring gear torque of 30,000 lb in at lower speeds. Lubrication of the test axle may either be by normal bath lubrication or by forced

* MS received 24 March 1961.

† Lubrication and Wear Division, National Engineering Laboratory, Thorntonhall, Glasgow.

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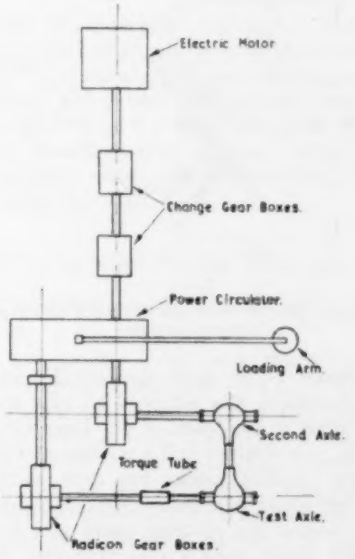

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circulation through external heaters or coolers; under forced feed the oil is supplied to the teeth on the engagement side. A torque tube is fitted to the half shaft of the test gear to measure the axle torque, and the temperatures of the oil at entry and in the sump may be recorded.

For the present experiments an axle casing was modified to insulate the pinion electrically from the rest of the rig. Thin " Tufnol " bushes and seatings were fitted around the pinion bearings, and these, together with the existing rubber coupling, proved satisfactory. It had been feared that the modification might affect the tooth alignment, but examination of the contact markings on assembly and after test showed no adverse effect, while the gears themselves performed satisfactorily up to loads as high as those reached safely with a normal pinion mounting. The simple electrical circuit used for measuring the contact resistance is shown in Fig 2. External contact was made to the gears using silver graphite brushes bearing on the driving flanges of the pinion and of the axle. The flanges were re-machined and cleaned to improve the contact. Two brushes were fitted on each flange; it was thus possible to check the brush resistance by connecting them in series, and

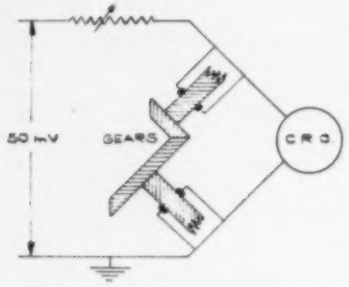

Fig 2

ELECTRICAL CIRCUIT FOR THE CONTACT RESISTANCE MEASUREMENTS

this was found to be approximately 1 ohm. The dropping resistance was adjusted to give half-scale deflection when a resistance of 10 ohms was put in place of the gear contact and a maximum voltage of 50 mV was applied across the gear teeth. The potential difference, and hence after calibration the resistance, across the rotating gears was measured with a CRO which gave 1 mm deflection for each 7·3 mV applied to the plates.

The experiments were most often run with the time base of the oscilloscope adjusted to give repetitive traces of about 50 msec, corresponding to about one-quarter turn of the pinion at an axle speed of 60 rev/min, *i.e.* the engagement of two successive teeth of each gear. At higher axle speeds these traces correspond to a greater number of contacts. Some of the traces showed interesting variations in the resistance pattern, and in one experiment the time base was triggered at a definite point in the meshing cycle. Fig 3 shows the position of the teeth at the instant of triggering. One tooth is just making contact, one tooth has just broken contact, and two intermediate teeth are in full contact. It may be noted that any one pair of teeth, therefore, are in contact for a

Fig 3

STAGE IN THE MESHING CYCLE AT WHICH THE TIME BASE WAS TRIGGERED

period covering about two and a half successive meshing cycles.

EXPERIMENTAL PROCEDURE

(1) *To Investigate the Effect of Different Operating Conditions*

A set of unphosphated back axle gears was carefully " run-in " or conditioned at 62 rev/min and at various loads up to the maximum designed load until both the drive and coast faces were well burnished; this involved about ¼ to ½ hour's running at each load. A commercial back-axle oil (EP oil) was used as the lubricant. Details of this oil and another oil used in the experiments are given in Table I.

Table I

Lubricants

Lubricant	Viscosity, cS at 60° C	Additive content
SAE 90 EP oil	66	Dibenzyl disulphide, chlorinated paraffin wax, antioxidant
Straight mineral oil	80	Completely free of additives

The oil used for running-in was drained and the axle filled with fresh EP oil. Tests were then commenced to investigate the effect of speed, load, and temperature on the resistance, and hence on the oil film between the gears. Tests were run first with the gears loaded on the drive side, then on the coast side. After the tests with the EP oil had been completed, the oil was drained and the gears and sump flushed with a thin oil. The axle was filled with a straight

mineral oil which was about 20 per cent more viscous than the EP oil over the range of bulk-oil temperatures used in the experiments. Selected tests were then repeated to investigate the effect of the increased oil viscosity. In general, only one of the three variables of speed, load, and bulk-oil temperature was allowed to reach a high value and, except in one test, conditions under which the gears would scuff were avoided.

The conditions in the tests selected for discussion are given in Table II. Oil temperatures quoted are sump temperatures.

TABLE II
Test Conditions

Test no.	Lubricant	Speed, rev/min	Torque, lb in	Temp, ° C	Running time, hr	Loaded face	Fig no.	Remarks
1	EP oil	10–800 × 100	1000	30	1	Drive	4	
2	EP oil	62	1000–15,600 × 1000	30	1	Drive	5	
3	EP oil	62	1000	30–90 × 10	1	Drive	6	
4	EP oil	62	1000–15,600 × 1000	30	1	Coast	8	
5	EP oil	600	10,000	90	1	Drive	9	
6	EP oil	62	1000	30	1	Drive	10	Trace triggered at stage shown in Fig 3
7	Straight oil	62	1000–15,600 × 1000	30	1	Drive	7	
8	EP oil	62	1000–15,600 × 3000	100	8 at each load	Drive	11	
9	EP oil	62	15,600	100	20	Drive	12	

(2) *To Investigate the Effect of Running-in*

It was to be expected that the surface conditioning which had taken place during the preliminary period of running-in would be of importance for the establishment of an oil film. Consequently, a number of tests were carried out with a second set of " green " gears to investigate the effect of time of running on the resistance between the gears. These tests were carried out with the EP lubricant at 62 rev/min and at a load which was increased from 1000 to 15,600 lb in by increments of 3000 lb in. Running was continued at each load until it appeared that equilibrium conditions had been attained. The temperature of the lubricant was not controlled, except to limit it to 100° C by cooling if it tended to exceed that value.

RESULTS

The results are presented as photographic records of the CRO traces obtained during the tests. These records were always made after stable operating conditions had been attained. For easy association of trace with test conditions the figure numbers have been included in Table II.

THE SIGNIFICANCE OF CONTACT RESISTANCE MEASUREMENTS

The resistance of an oil film $\frac{1}{1000}$ sq inch in area and 1 micro-inch thick is in excess of 10^7 ohms. Boundary lubrication involves films of molecular thickness and contact resistance of less than 1 ohm.[4] In the present experiments when the measured resistance was very high (marked o0 on the traces) it can be assumed that the teeth were completely separated by an oil film. On the other hand, resistances of a few ohms or less (marked 0 on the traces) indicated the occurrence of at least local metal-to-metal contact or the presence of an extremely thin oil film which allowed a current to flow under the applied voltage. Even if only the latter occurred, the initial oil film must have been very much thinner than when the resistance was high. The maximum voltage applied across the gear teeth was 50 mV, and this would produce a potential gradient of 5×10^4 V/in across an oil film 1 micro-inch thick. This is less by a factor of ten than the values of dielectric strength associated with mineral oils in bulk, so it seems unlikely that unwanted electrical breakdown of the oil took place.

DISCUSSION OF RESULTS

The Effect of Speed and Load on the Existence of an Oil Film

Increase of speed as shown in Fig 4 promotes the formation of an appreciable oil film during at least part of the meshing cycle. At very high speeds there is a trend towards conditions of lower resistance due to the effect of a high gear surface temperature in limiting the oil film thickness. Increase in load (Fig 5) has an adverse effect on the formation of an oil film. The effect of these variables in the expected direction confirms that the presence of a hydrodynamic film is being detected.

The Effect of Viscosity and Bulk Oil Temperature

Fig 6 shows the effect of bulk oil temperature. Increase in temperature decreases the tendency for an oil film to form, as might be expected from its effect on viscosity, but at temperatures above 50° C there is an increase in the occurrence of periods of high resistance. When the oil was heated through a

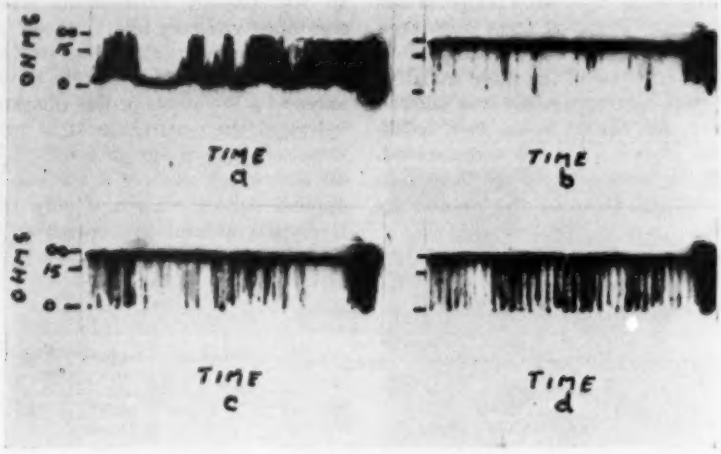

FIG 4

EFFECT OF SPEED—DRIVE SIDE, 1000 lb in, 30° C

(*a*) 10 rev/min (*b*) 60 rev/min
(*c*) 400 rev/min (*d*) 800 rev/min

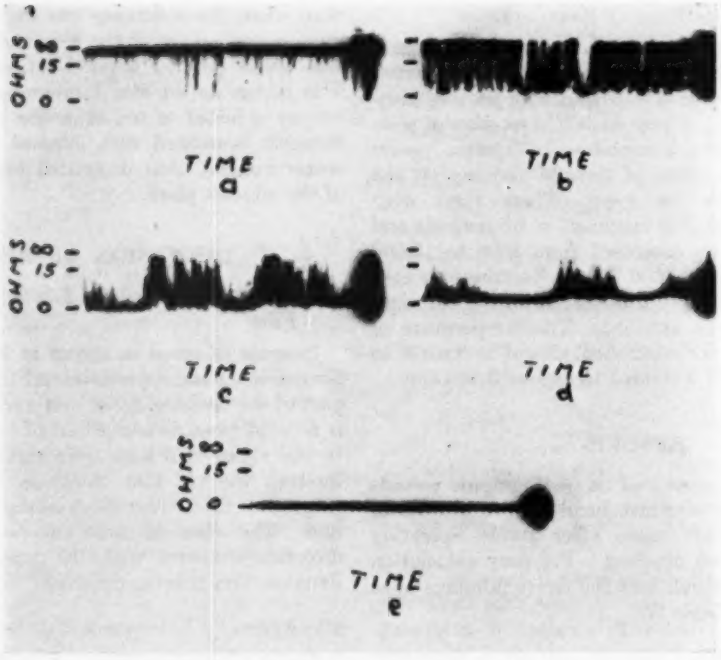

FIG 5

EFFECT OF LOAD—DRIVE SIDE, 62 rev/min, 30° C

(*a*) 1000 lb in (*b*) 4000 lb in
(*c*) 8000 lb in (*d*) 12,000 lb in
(*e*) 15,000 lb in

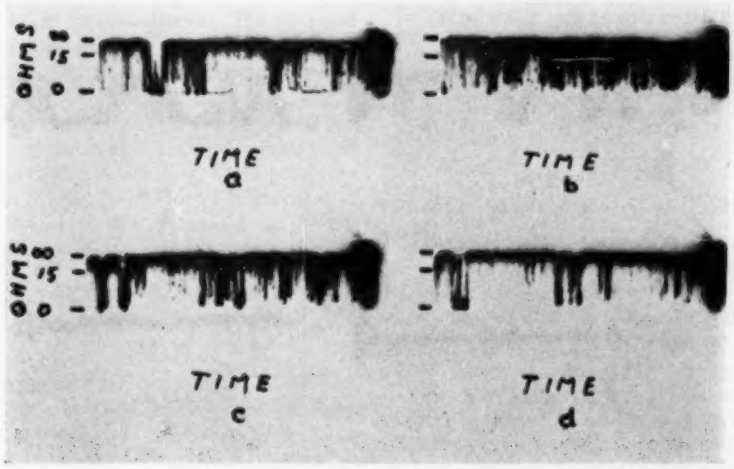

FIG 6

EFFECT OF TEMPERATURE—DRIVE SIDE, 62 rev/min, 1000 lb in

(*a*) 30° C (*b*) 50° C
(*c*) 70° C (*d*) 90° C

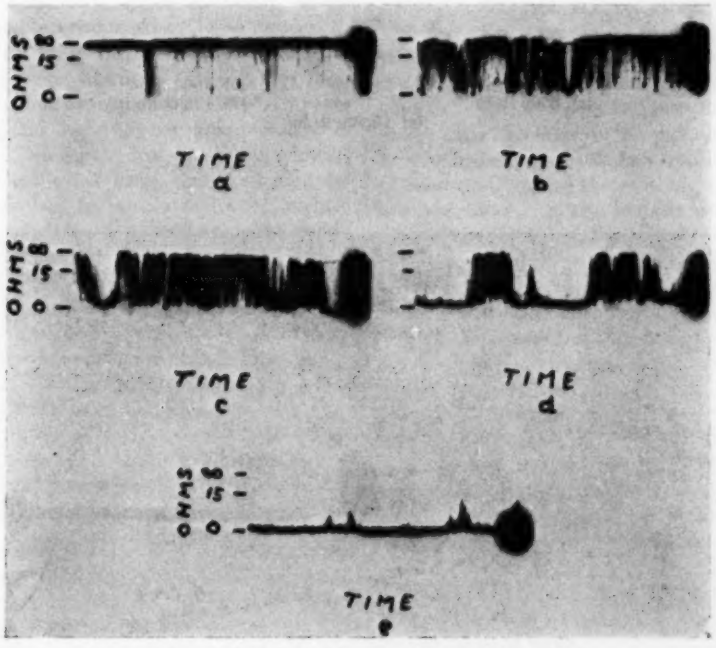

FIG 7

EFFECT OF LOAD WITH THE MORE VISCOUS OIL—DRIVE SIDE, 62 rev/min, 30° C

(*a*) 1000 lb in (*b*) 4000 lb in
(*c*) 8000 lb in (*d*) 12,000 lb in
(*e*) 15,600 lb in

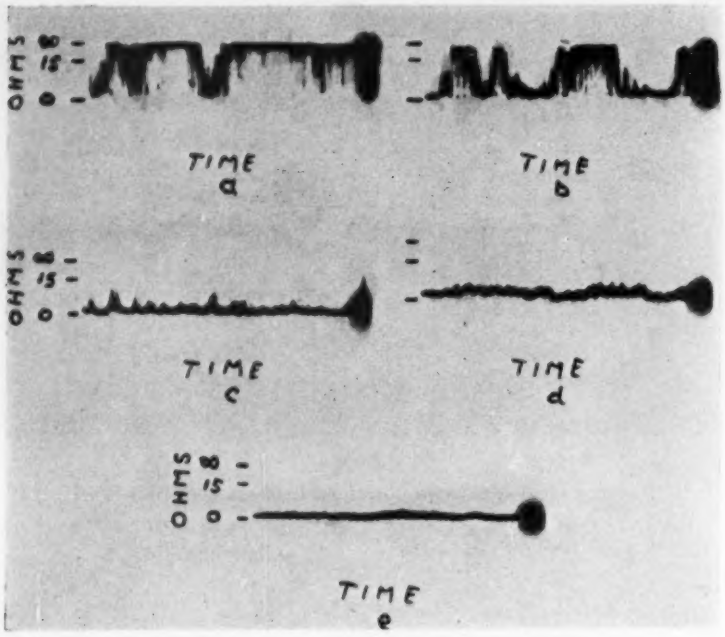

FIG 8

EFFECT OF LOAD—COAST SIDE, 62 rev/min, 30° C

(*a*) 1000 lb in (*b*) 4000 lb in
(*c*) 8000 lb in (*d*) 12,000 lb in
(*e*) 15,600 lb in

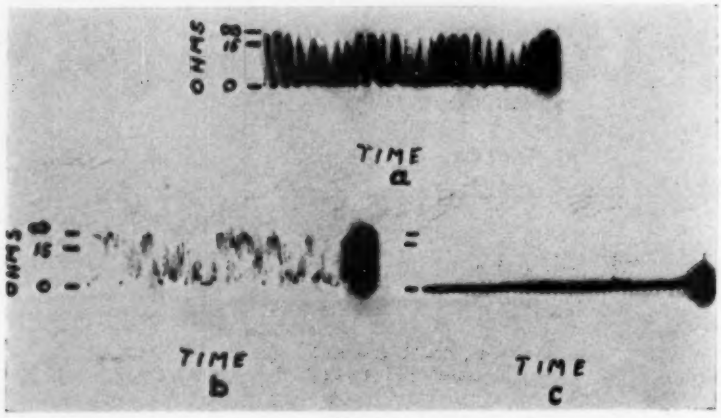

FIG 9

PRACTICAL CONDITIONS—DRIVE SIDE, 600 rev/min, 10,000 lb in, 90° C

(*a*) 50 ms sweep (*b*) 5 ms sweep
(*c*) After scuffing

similar temperature range in a static test there was a continuous decrease in its resistance. The increase in resistance during the axle test cannot therefore be attributed to changes in the oil, and may be due to some unbalanced expansion in the axle rig. Fig 7 when compared with Fig 5 shows the effect of a 20 per cent increase in the viscosity of the oil. An equivalent degree of breakdown of the oil film corresponds to loads which are about 3000 lb in greater in the case of the thicker oil. Easier electrical breakdown of the additive oil is a less likely explanation of this observation.

The Effect of Carrying the Load on the "Coast" Side of the Teeth

For equivalent experimental conditions, an oil film forms less readily when the load is carried on the coast side than when it is carried on the drive side. This feature was found in a number of the tests and is illustrated when Fig 8 is compared with Fig 5. These observations are consistent with the fact that for equivalent conditions scuffing takes place more readily on the coast side of the teeth.

Severe Operating Conditions and the Role of EP Additives

It would seem that even under relatively severe conditions appreciable oil films can exist during at least part of the meshing cycle. Figs 9 (*a*) and (*b*) are traces which were obtained at 600 rev/min, 10,000 lb in torque, and a temperature of 90° C; these conditions correspond to a power transmission of 95 hp at 50 mph. During the low resistance parts of the cycle, lubrication must have been provided by EP films, as evidenced by the absence of surface damage to the gear teeth. Measurements made across the stationary gears after tests with the EP oil confirmed that any EP films which had formed did not contribute sufficiently to the resistance of the gear contact to affect the measurement. This may well have been due to the fact that no general build-up of a substantial EP film took place on the gears during a test. If it is assumed that the most important action of EP additives does not take place when appreciable oil films are present, then the present experiments would seem to indicate that EP additives have four main functions in gear lubrication:

(1) To provide lubrication during those periods in the meshing cycle when the lubrication is not hydrodynamic.

(2) To provide lubrication during stopping and starting when boundary conditions predominate.

(3) To provide lubrication at very high speeds when the surface temperature attained by the gears would seem to be the factor which limits oil film thickness.

(4) To assist in recovery from any incipient surface failures on the way to the well run-in state which might otherwise prove catastrophic.

Trace 9 (*c*) was obtained at an axle speed of 600 rev/min after the gears had been scuffed and the axle filled with a fresh charge of the EP oil; with the scuffed gears a very low resistance was recorded throughout the meshing cycle.

Variation of Resistance within the Meshing Cycle

The traces other than those corresponding to high torques at low speeds show variations in resistance occurring throughout the meshing cycle; this is an indication that the thickness of the oil film varies during the meshing cycle. The 24 cycles of variation in resistance which can be observed in trace 9 (*a*) indicates meshing of teeth and corresponds to the two-cycle variation which can be observed in some of the tests run at 62 rev/min and to the two-cycle variation in trace 9 (*b*), which is a 5-ms sweep. There is thus a definite fluctuation in the resistance pattern which is associated with tooth contact frequency.

Figs 10 (*a*) and (*b*) are 50- and 150-ms sweeps respectively, triggered in each case at that stage of tooth engagement shown in Fig 3. These traces are of particular interest, as they enable the gross fluctuations in resistance to be related to the phase of contact. The traces start (time scale from right to left) just after a period when the instantaneous values of the resistance are very low. Fig 3 shows that at the instant of triggering one pair of teeth has just disengaged and one pair is just entering the meshing cycle, with two intervening pairs making full contact. It would seem that where variation of resistance can be measured during the meshing cycle, the periods of low resistance, *i.e.* the periods when a very thin oil film or localized metallic contact exists somewhere in the engagement, occur when the maximum number of pairs of teeth are in contact. In view of the adverse effect of increased load on the formation of an oil film, it might be expected that the reduced tooth loading which results during the periods of maximum contact would promote the formation of a thicker oil film. However, these periods are also periods of engagement and disengagement of teeth, and the high gear surface temperatures, which result from the consequent preponderance of sliding, limit the oil film thickness. It may be significant that drive side scuffing is usually observed to start in the area over which disengagement of teeth is taking place. The best conditions of lubrication occur at and just following the stage pictured in Fig 3 when the load is carried by the fewest pairs of teeth.

The Effect of Running-in

The effect of running-in, which was investigated on the second set of gears, is illustrated in Fig 11. After each increment of load the contact conditions and the

FIG 10

TRIGGERED TRACES—DRIVE SIDE, 62 rev/min, 10,000 lb in, 30° c

(*a*) 50 ms sweep (*b*) 150 ms sweep

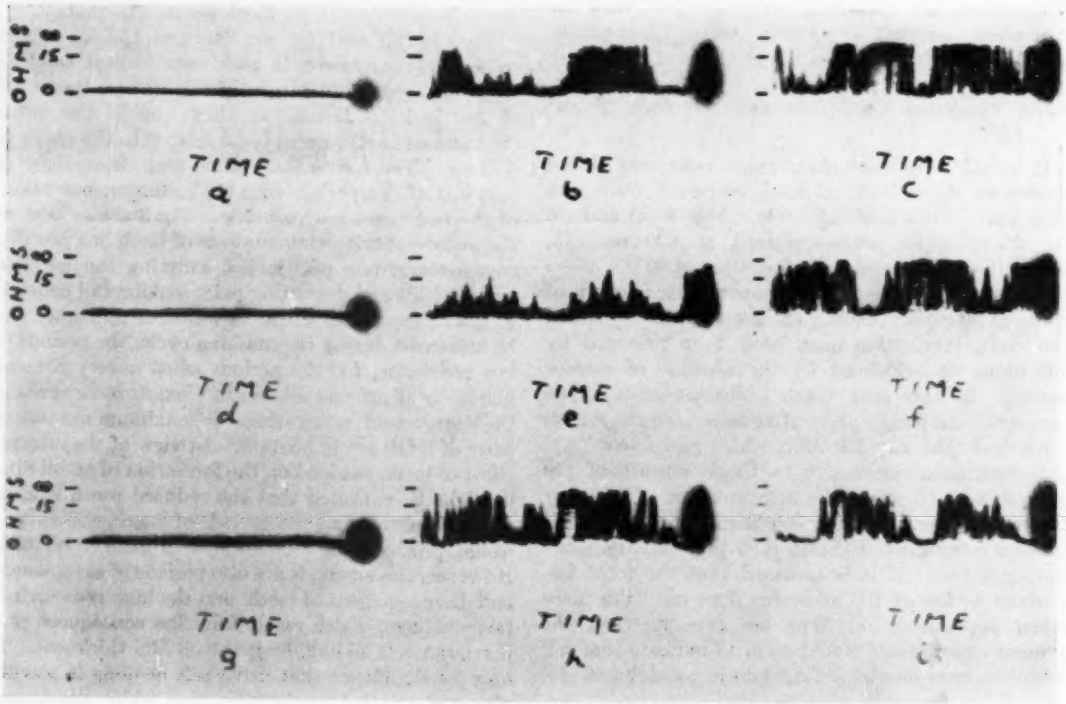

FIG 11

EFFECT OF "RUNNING-IN"—DRIVE SIDE, 62 rev/min

(*a*) Start at 1000 lb in (*b*) After four hours running at 1000 lb in (*c*) After eight hours running at 1000 lb in
(*d*) Start at 8000 lb in (*e*) After three hours running at 8000 lb in (*f*) After six hours running at 8000 lb in
(*g*) Start at 15,000 lb in (*h*) After three hours running at 15,600 lb in (*i*) After seven hours running at 15,600 lb in

degree of hydrodynamic lubrication improve with time of running. This is shown by the increase of resistance which takes place during the appropriate part of the meshing cycle, indicating that appreciable oil films are gradually being established (or gradually re-established after there has been an increase in load). The increments of load were equal, and after the addition of each increment the time taken for the resistance to reach a steady (maximum) value was reasonably constant (about 10 hours). When the conditions of lubrication characteristic of well run-in ing the rig to cool was to produce poorer hydrodynamic conditions on the re-start, due presumably to the roughening of the surfaces which had occurred during the boundary conditions of stopping and starting.

It seems likely that the effect of running-in is to wear away, or cause to flow plastically, asperities which initially penetrate the oil film and hence produce a low resistance. As the surface finish improves, hydrodynamic conditions appear and gradually become well established.

The results on running-in are of interest when

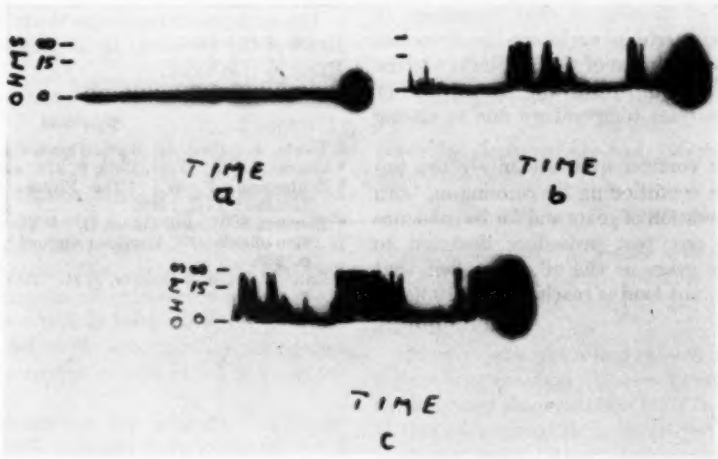

FIG 12

EFFECT OF " RUNNING-IN "—DRIVE SIDE, 62 rev/min, 15,600 lb in

(*a*) Re-start from cold after seven hours running
(*b*) Re-start from cold after 13 hours running
(*c*) Re-start from cold after 17 hours running

surfaces have been attained at a particular load there is a reversion to less favourable conditions if there is an increase in load.

A feature of the running-in tests was that if after well run-in conditions had been attained the test was stopped and the axle allowed to cool to room temperature, then on re-starting from cold at the same load there was a reversion to less favourable conditions of lubrication. Fig 12 was obtained as the result of further investigation of this effect, and shows traces corresponding to a number of starts from cold made at maximum load with the second set of gears after the running-in tests had been completed. The deterioration obviously becomes less marked with running time. With well run-in gears this deterioration did not take place if the stopping and re-starting was carried out without allowing the rig to cool. On the other hand, in tests with a set of gears which had been only moderately well run-in, the effect of a few stops and re-starts without allowcompared with those of Crook,[2] who found that the thickness of the oil film between disks which had both rolling and sliding relative motion increased to an equilibrium value as the test proceeded. The observations contrast with those of Lane and Hughes[5] in their work with spur gears. These authors found that there was no improvement in lubrication with time of running. The explanation of the difference lies in the fact that Lane and Hughes started with very well finished test gears which left little room for improvement so far as surface finish was concerned.

CONCLUSIONS

The results suggest that under loads, speeds, and temperatures corresponding to the usual full-scale axle tests, full fluid films prevail between the teeth of a moderately well run-in set of hypoid gears during at least part of the meshing cycle, except at high loads and low speeds. This observation is consistent with

the remarkably small amount of wear which takes place when a set of gears is operating satisfactorily. The relatively extensive occurrence of these oil films may explain why small-scale laboratory tests, run under conditions which almost certainly preclude the formation of oil films, fail to give a reliable evaluation of hypoid oils.

The function of EP additives may be to preserve a surface finish conducive to the maintenance of hydrodynamic conditions. The present experiments have not dealt with bump or shock conditions, during which the EP additive could play its most important role of all.

The results are of interest in that variations in severity during the meshing cycle can be detected. They show that the thickness of the oil film is not the same over the tooth surface; the film is very thin or absent where the surface temperature due to sliding is higher.

The experiments confirm quite definitely the importance of surface conditioning by running-in, both for the practical operation of gears and for its influence on the results of any test procedure designed to evaluate either the gears or the oil. The fact that equilibrium at constant load is reached after 10 hours running at 60 rev/min should be borne in mind in formulating a satisfactory running-in period to precede any test procedure on an axle rig.

ACKNOWLEDGMENTS

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INCREASE IN *JOURNAL* SUBSCRIPTIONS

The price of the annual subscription to the *Journal* for non-members of the Institute has remained at £4 14*s*. 6*d*. since 1950. During that time there have been several increases in the costs of printing, and it is now regretted that the price of *Journal* subscriptions are of necessity having to be increased.

Therefore the cost of annual subscriptions with effect from the January 1962 issue *will be 6 guineas*.

The price of individual copies will at the same time be increased from 10*s*. to 12*s*. 6*d*.

SYNERGISTIC AND ANTAGONISTIC EFFECTS OF ANTI-OXIDANTS ON A HYDROCARBON OIL *

By K. U. INGOLD†

SUMMARY

A preliminary survey of the effects produced by combinations of two free radical inhibitors on the induction period of a saturated white mineral oil has been undertaken. All the inhibitors, which were aromatic amines and phenols, could decompose the hydroperoxides formed during autoxidation of the oil, although the rates of decomposition varied markedly with the inhibitor. Combinations of two inhibitors might have either synergistic, additive, or antagonistic effects on the induction period, although many apparently antagonistic combinations were shown to be actually additive or synergistic when allowance was made for the kinetic order of the inhibition process. The present work suggests that synergism results mainly from one inhibitor functioning as a peroxide decomposer and the other as a free radical trap, although the correlation between the magnitude of the synergistic effects and the relative rates of peroxide decomposition is rather poor. Antagonism appears to be due to several causes, among which a cross-combination reaction between inhibitor radicals is probably of major importance, although the formation of association complexes with a low reactivity towards peroxy radicals may play a part in some mixtures.

INTRODUCTION

WHEN two or more anti-oxidants are used together to inhibit the autoxidation of an organic substrate, their combined effect is frequently greater than the sum of their individual effects. The anti-oxidants are then said to show a synergistic effect towards one another, and the component which is least active, or even inactive, by itself is called the synergist for the second component. The converse of this effect is antagonism.

The reaction scheme for the autoxidation of an organic substrate, RH, is generally formulated:

$$RH + O_2 \longrightarrow R^{\cdot} + HO_2^{\cdot} \quad . \quad . \quad (1)$$
$$R^{\cdot} + O_2 \longrightarrow RO_2^{\cdot} \quad . \quad . \quad . \quad . \quad (2)$$
$$RO_2^{\cdot} + RH \longrightarrow ROOH + R^{\cdot} \quad . \quad . \quad (3)$$
$$ROOH \longrightarrow RO^{\cdot} + {}^{\cdot}OH \quad . \quad . \quad (4)$$
$$RO_2^{\cdot} + RO_2^{\cdot} \longrightarrow \text{Inactive products.} \quad (5)$$

Anti-oxidants are generally divided into two main classes, free radical inhibitors (IH), which destroy peroxy radicals, and peroxide decomposers (D), which destroy hydroperoxides. The former consist almost invariably of substituted phenols or aromatic primary or secondary amines. These compounds are able to donate a hydrogen to the peroxy radical to give a hydroperoxide and a new radical I$^{\cdot}$, which is generally stabilized by resonance and may, therefore, be insufficiently reactive to start a new oxidation chain. Reaction (3), a chain propagating process, tends to be replaced by a new reaction which is effectively chain ending.

$$RO_2^{\cdot} + IH \longrightarrow ROOH + I^{\cdot} \quad . \quad . \quad (6)$$

The decomposition of hydroperoxides by reaction (4) is the major source of chain initiation in most autoxidations. Destruction of hydroperoxide, without the formation of free radicals, by the addition of a peroxide decomposer will, therefore, also inhibit autoxidations.

$$ROOH + D \longrightarrow \text{Non-radical products} \quad . \quad (7)$$

This reaction may be either a stoichiometric process (*e.g.* with certain organic sulphides,[1,2] and phosphorus derivatives[3,4]) or a catalytic one (*e.g.* with sulphonic acids[5]).

However efficient a free radical inhibitor may be at suppressing reaction (3) some hydroperoxide is bound to be formed from reaction (6) if from no other source. If this hydroperoxide is destroyed by a peroxide decomposer before it can decompose into free radicals the effectiveness of the free radical inhibitor will be increased. Furthermore, since the peroxide decomposer may itself be subject to attack by peroxy radicals,[2,3] its own effectiveness is also improved by the free radical inhibitor. It is clear, therefore, that a free radical inhibitor and a peroxide decomposer play complementary roles in inhibiting autoxidations, and it is for this reason that synergistic effects are frequently observed when anti-oxidants of both types are used in conjunction with one another.[6] Synergism has also been observed between anti-oxidants which are formally free radical inhibitors.[7-9]

The present work was undertaken primarily as a general survey of the effects of mixed free radical inhibitors of several different chemical types on the induction period of a hydrocarbon oil. An attempt was made to determine whether the synergistic effects which were encountered were attributable to one of the free radical inhibitors functioning primarily as a peroxide decomposer, or whether they must be due to some other cause.

RESULTS

A saturated white mineral oil was used as the organic substrate throughout this work. The apparatus and

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procedure for measuring induction periods have been described previously.[7,10] The inhibitors, and the abbreviations that will be used for them in the figures, are given in Table I. For each inhibitor, the induction periods due to that inhibitor (*i.e.* the induction period of the inhibited oil minus that of the uninhibited oil) were measured at several concentrations at 160° C. Some of the kinetic curves are shown in Fig 1.

TABLE I

List of Inhibitors

2,6-Di-*t*-butyl-4-methyl phenol	BMP
2,4,6-Tri-*t*-butyl phenol	TBP
2,2′-Methylene-bis (6-*t*-butyl-4-methyl phenol)	MBBP
2,4,6-Tri-methyl phenol	TMP
α-Naphthol	AN
4-Methyl phenol	MP
4-Methoxyphenol	MXP
α-Naphthylamine	ANA
β-Naphthylamine	BNA
N-Phenyl-α-naphthylamine	PAN
N-Phenyl-β-naphthylamine	PBN
Diphenylamine	DPA
4-Hydroxydiphenylamine	HDPA
4-Methoxyaniline	MXA
N,*N*′-Di-*sec*-butyl-*p*-phenylenediamine	BPPD

The induction periods (t) obtained at 160° C with the different inhibitors, at the concentrations indicated, are given in Table II to the nearest 5 minutes. Except for three rather strong inhibitors, the concentration is 5×10^{-4} g mol/litre, but with these three inhibitors the induction period would have been inconveniently long at this concentration, particularly when they were mixed with a second inhibitor. The synergistic or antagonistic effects obtained with mixtures of two inhibitors, at the concentrations indicated, are also given in Table II; a positive sign signifies synergism and a negative sign antagonism. The first of the two numbers given for each pair of inhibitors represents the extent of synergism or antagonism in minutes calculated on a simple arithmetic basis. For example, the induction period obtained with a mixture of 2,6-di-*t*-butyl-4-methyl phenol and 2,4,6-tri-*t*-butyl phenol, both at 5×10^{-4} g mol/litre, was 230 minutes, whereas the value calculated from their individual induction periods at this concentration would be 170 + 110 = 280 minutes. Since the measured value is less than this calculated value, the difference of 50 minutes is antagonistic and is represented by −50 in the Table. The experimental induction period that was obtained with any mixture can be readily calculated from the results in Table II.

The results plotted in Fig 1 show that, under the present experimental conditions, the induction period

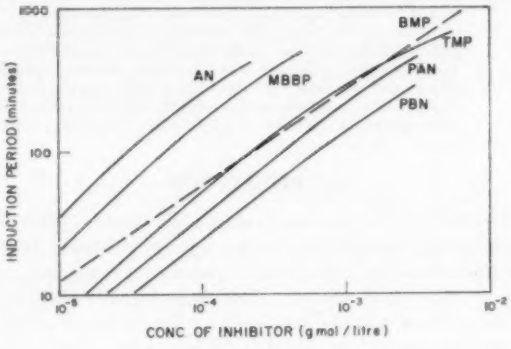


FIG 1

INDUCTION PERIOD *v.* INHIBITOR CONCENTRATION

is proportional, not to the first power of the inhibitor concentration, but to some fractional power between 0·5 and 1·0. Moreover, with the exception of 2,6-di-*t*-butyl-4-methyl phenol and 2,4,6-tri-*t*-butyl phenol,[11] the order decreases as the inhibitor concentration is increased. Since the kinetic order is less than unity (except for some inhibitors at low concentrations), doubling the concentration of an inhibitor will not double the induction period. Therefore, the arithmetically calculated induction periods will always be too large and may well indicate that the inhibitors are antagonistic, even though they are, in actual fact,

TABLE II

Induction Periods of Inhibitors—Synergism and Antagonism of Mixed Inhibitors

Inhibitor			BMP	MBBP	AN	TMP	PAN	DPA
	Concn, g mol/litre		5×10^{-4}	$1{\cdot}5 \times 10^{-4}$	5×10^{-5}	5×10^{-4}	5×10^{-4}	5×10^{-4}
		t, min	170	220	150	185	125	45
TBP	5×10^{-4}	110	−50(0)	−65(0)	−5(30)	−70(−30)	−25(20)	20(50)
MBBP	$1{\cdot}5 \times 10^{-4}$	220	−65(5)	—	−90(−30)	−10(100)	10(60)	100(125)
AN	5×10^{-5}	150	−40(5)	−90(−30)	—	−90(−10)	30(80)	15(40)
TMP	5×10^{-4}	185	100(160)	−10(100)	−90(−10)	—	−75(−15)	−5(25)
MXP	5×10^{-4}	60	115(145)	40(60)	−55(10)	−55(−20)	−65(−45)	−30(−10)
MP	5×10^{-4}	15	35(50)	−15(0)	−25(−10)	−30(−20)	−40(−35)	−20(−15)
ANA	5×10^{-4}	35	40(60)	65(80)	20(30)	−10(15)	20(40)	0(15)
BNA	5×10^{-4}	20	20(40)	40(50)	−5(10)	0(10)	20(30)	0(10)
MXA	5×10^{-4}	30	105(115)	60(70)	5(15)	20(0)	15(25)	0(10)
PAN	5×10^{-4}	125	35(95)	10(60)	30(80)	−75(−15)	—	10(30)
PBN	5×10^{-4}	80	85(125)	10(50)	30(50)	−45(0)	−25(20)	−20(0)
DPA	5×10^{-4}	45	110(130)	100(125)	15(40)	−5(25)	10(30)	—
HDPA	5×10^{-4}	220	−65(0)	−100(−40)	−90(−25)	−120(−20)	−50(0)	−25(0)
BPPD	$2{\cdot}5 \times 10^{-4}$	260	15(100)	−105(−30)	−20(35)	−140(−30)	−60(−15)	−10(20)

inactive, or even perhaps mildly synergistic, towards one another. This over-estimation of antagonistic effects can be approximately allowed for by making use of the measured kinetic orders to calculate the expected induction period. To take the same example again, it can be seen from Fig 1 that the induction period of 110 minutes which is obtained with 5×10^{-4} g mol/litre of tri-*t*-butyl phenol is also obtained with $2{\cdot}5 \times 10^{-4}$ 2,6-di-*t*-butyl-4-methyl phenol, *i.e.* these two inhibitors have an equal effect at these concentrations. Therefore, the effect of both inhibitors together, each at 5×10^{-4} g mol/litre, should be equivalent to the effect of $7{\cdot}5 \times 10^{-4}$ 2,6-di-*t*-butyl-4-methyl phenol, a concentration which is seen from Fig 1 to give an induction period of 230 minutes in agreement with the measured value for the mixture. That is, under these conditions and after allowing for the non-integral kinetic order, these two inhibitors behave in a truly additive fashion, since their mixture shows neither synergism nor antagonism. This is represented by (0) in the table, *i.e.* the second number given in brackets for each pair of inhibitors represents the true synergistic (+) or antagonistic (−) effect determined in this way. In all cases, the equivalent concentration of the stronger of the two components in the mixture has been used to estimate the induction periods, since it seems probable that the kinetic order of this inhibitor is of more importance than the order of the weaker inhibitor.

For simplicity, Table II gives the results obtained at only one concentration of each inhibitor. However, the occurrence of synergism or antagonism was confirmed for the majority of inhibitors by measurements at two or three different concentrations. Some typical results for two synergistic and two antagonistic mixtures are given in Table III.

TABLE III

Synergistic and Antagonistic Combinations of Inhibitors at Different Concentrations

Concn, g mol/litre	PBN	10^{-3}	5×10^{-4}	5×10^{-5}
BMP	*t*, min	135	80	15
10^{-3}	275	105(175)	85(150)	15(35)
5×10^{-4}	170	95(150)	85(125)	20(40)
5×10^{-5}	35	65(80)	45(60)	20(40)
Concn, g mol/litre	DPA	10^{-3}	5×10^{-4}	5×10^{-5}
PAN	*t*, min	60	45	15
10^{-3}	230	45(85)	25(55)	10(20)
5×10^{-4}	125	30(60)	10(30)	5(15)
5×10^{-5}	20	5(15)	5(10)	0(5)
Concn, g mol/litre	TMP	10^{-3}	5×10^{-4}	5×10^{-5}
PAN	*t*, min	275	185	30
10^{-3}	230	−170(−60)	−110(−50)	−40(−20)
5×10^{-4}	125	−90(−35)	−75(−15)	−30(−10)
5×10^{-5}	20	−15(0)	−10(0)	−5(0)
Concn, g mol/litre	BPPD		$2{\cdot}5 \times 10^{-4}$	5×10^{-5}
MBBP	*t*, min		260	100
$1{\cdot}5 \times 10^{-4}$	220		−105(−30)	−80(−30)
5×10^{-5}	90		−70(−30)	−35(−20)

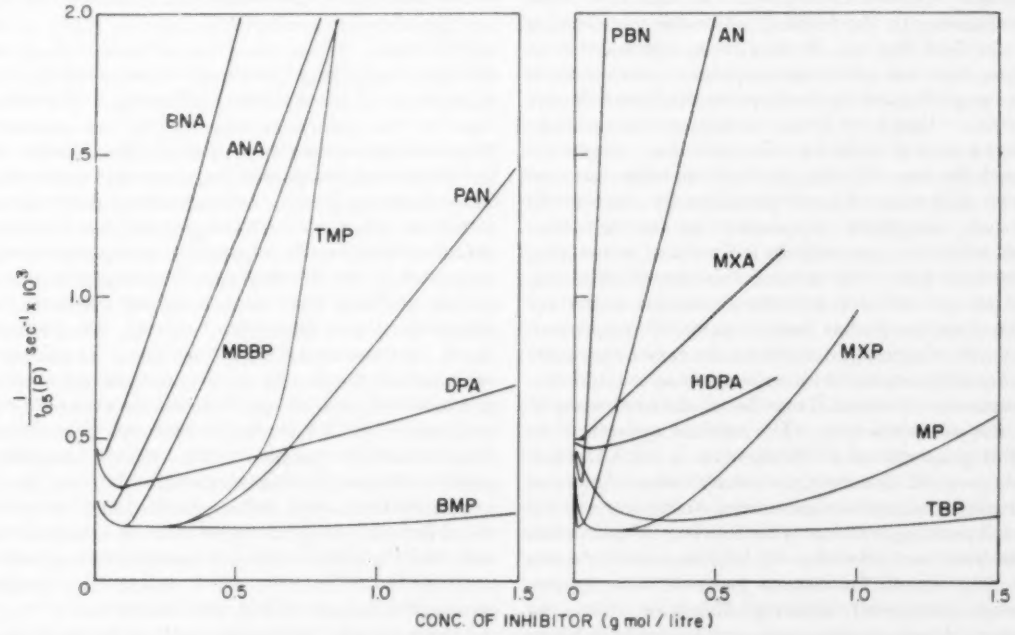


FIG 2

RATE OF PEROXIDE DECOMPOSITION *v.* INHIBITOR CONCENTRATION

The influence of free radical inhibitors on the rate of decomposition of the hydroperoxides formed in the autoxidized oil was examined to see whether their effects could be correlated with the synergism or antagonism exhibited by the mixed inhibitors. The oil was pre-oxidized to a peroxide content of 0·06 mol/litre. The rate of decomposition of these peroxides in the absence of oxygen at 150° C was followed by the technique described previously[10] with several concentrations of each inhibitor. The results are plotted as reciprocal half lives for peroxide decomposition ($1/t_{0\cdot5}(P)$ sec^{-1}) against inhibitor concentration in Fig 2. The accuracy of many of the curves is not high since they are based on only four or five points.

DISCUSSION

In the absence of a peroxide decomposer, hydroperoxides can decompose by a bimolecular reaction and by an induced chain reaction, in addition to the unimolecular process (reaction 4)

$$2ROOH \longrightarrow RO^{\cdot} + RO_2^{\cdot} + H_2O \quad . \quad (8)$$

$$X^{\cdot} + ROOH \longrightarrow \text{Free radicals} \quad . \quad . \quad . \quad (9)$$

where $X^{\cdot}$ represents a free radical such as $RO^{\cdot}$, $RO_2^{\cdot}$, etc. Low concentrations of free radical inhibitors tend to suppress reaction (9), and the rate of peroxide decomposition is therefore decreased. Provided the inhibitor is a sufficiently strong free radical trap, reaction (9) may be eliminated, and the rate is then depressed to a definite reproducible minimum value corresponding to the residual molecular reactions (4) and (8) (see Fig 2). It has been reported[12] that oxygen does not affect the minimum rate obtained with α-naphthol and the hydroperoxides from *n*-decane at 130° C. Under the present conditions, using 2,6-di-*t*-butyl-4-methyl phenol as the inhibitor, oxygen decreased the rate slightly, probably because the concurrent formation of hydroperoxides by reaction (3) was not completely suppressed by the inhibitor. Weak inhibitors generally do not succeed in reducing the rate to quite such an extent as strong inhibitors, since an induced decomposition becomes important before reaction (9) has been completely suppressed. Even with the strong inhibitors the rate of peroxide decomposition starts to increase again as the inhibitor concentration is raised above the amount necessary to give the minimum rate. The increase appears to be roughly proportional to the increase in inhibitor concentration and, therefore, the relative rates of induced peroxide decomposition are related to the slopes of the upward pointing portions of the curves. This increase in rate was observed with every inhibitor, and indicates that they can all function as peroxide decomposers, although with greatly differing efficiencies. Thus the division of anti-oxidants into free radical inhibitors and peroxide decomposers is highly arbitrary, since it appears that the former can always function as the latter.

Fig 2 shows that the major cause of hydroperoxide decomposition in the presence of even a five-fold excess of several of the inhibitors is the induced process. Therefore, the inhibition of oxidation produced by the addition of one of these compounds to an unoxidized substrate that contains little or no hydroperoxide will be due to both reactions (6) and (7), since the hydroperoxide formed in the former reaction and in reaction (3) will be certain to react with the initial excess of inhibitor. These two reactions might even consume comparable quantities of inhibitor. Reaction (7) will play a still more important role for the inhibition of a partially oxidized substrate. For example, Denisov[13] has shown that the addition of the strong inhibitor, α-naphthol, to oxidizing *cyclo*hexane will prevent further oxidation for a time and will cause a decrease in the hydroperoxide concentration. He attributed the latter to the suppression of the reaction that leads to its formation (*i.e.* reaction (3)) without any corresponding suppression of the normal molecular reactions that destroy it (*i.e.* reactions (4) and (8)). However, since α-naphthol is also a strong peroxide decomposer, it seems likely that some of the decrease in hydroperoxide was due to reaction (7).

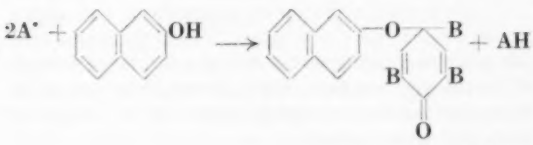
The two highly hindered phenols, 2,6-di-*t*-butyl-4-methyl phenol and 2,4,6-tri-*t*-butyl phenol, are quite strong inhibitors, but are very inactive peroxide decomposers (see Fig 2). Their rate of reaction with peroxides is, in fact, sufficiently small that the reaction can be neglected in the present autoxidations, and they can therefore be considered to function solely as free radical traps. The results given in Table II show that mixtures containing the former always exhibit true synergism, or, at the least, additivity. The occurrence of true synergism suggests that the second inhibitor is functioning as a peroxide decomposer, and the absence of antagonism suggests that none of the other inhibitors produce free radicals by their reaction with hydroperoxides. The suggestion that the second inhibitor functions as a peroxide decomposer is also supported by the fact that these two hindered phenols (acting probably only as free radical inhibitors) together show true additivity, whereas other antioxidants, that are structurally just about as similar to one another, frequently show true synergistic effects provided one or both can function as a peroxide decomposer; *e.g.* 2,6-di-*t*-butyl-4-methyl phenol with 2,4,6-tri-methyl phenol (160), phenyl-α-naphthylamine with phenyl-β-naphthylamine (20), and phenyl-α-naphthylamine with diphenylamine (30). However, the observed synergistic effects do not correlate very well with the relative rates of peroxide decomposition obtained from Fig 2, for which reason other possible causes of synergism will be first considered.

A very simple mechanism that could give rise to synergism involves the transfer of a hydrogen atom

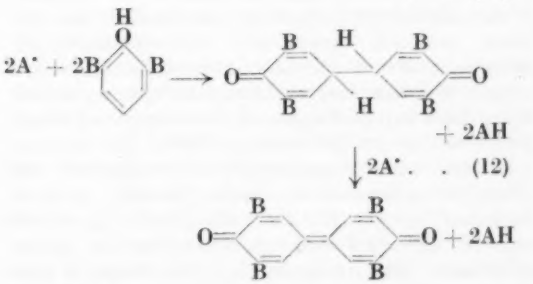
from the synergist (SH) to the inhibitor after the latter has lost its active hydrogen to a peroxy radical in reaction (6), *i.e.* the stronger inhibitor is regenerated from the weaker by the transfer of a hydrogen atom.

$$I^{\cdot} + SH \longrightarrow IH + S^{\cdot} \quad . \quad . \quad . \quad (10)$$

This mechanism is likely to be particularly favoured with the mixtures of free radical inhibitors studied in this work, since even the less active component should give a resonance stabilized free radical $S^{\cdot}$. Reactions of this type have been observed between the 2,4,6-tri-*t*-butyl phenoxy radical and phenols, naphthols,[14] other 2,6-di-*t*-butyl-4-substituted phenols,[15] and hydrazobenzene,[16] *e.g.*



. . (11)



where AH represents 2,4,6-tri-*t*-butyl phenol, $A^{\cdot}$ the corresponding phenoxy radical, and B the *t*-butyl group.

A molecule of inhibitor normally reacts with only two peroxy radicals, since the initially formed inhibitor radical either combines with a second peroxy radical or donates a hydrogen atom to it.[17] For mixtures containing equal concentrations of two inhibitors it is obvious that even if the weaker can donate two hydrogens to the stronger, the latter is effectively regenerated only once, whereas with reactions similar to reaction (11), only part of it is regenerated. Such mixtures cannot, therefore, give induction periods more than twice as long as the induction period of the stronger inhibitor alone and, in all probability, cannot give longer induction periods than would be obtained with twice the concentration of the stronger inhibitor. However, five inhibitors weaker than 2,6-di-*t*-butyl-4-methyl phenol do give longer induction periods with an equal concentration of this inhibitor than are obtained at twice its concentration. Thus the induction periods obtained with mixtures of the following inhibitors and 2,6-di-*t*-butyl-4-methyl phenol (both at 5×10^{-4} g mol/litre) can be readily calculated from the results in Table II; 4-methoxyphenol 345, phenyl-β-naphthylamine 335, phenyl-α-naphthylamine 330, diphenylamine 325, and 4-methoxyaniline 305, whereas the hindered phenol at 10^{-3} g mol/litre gave an introduction period of only 275 minutes. It can be seen that 4-methoxyphenol actually gives an induction period slightly more than twice as long as that of the hindered phenol at 5×10^{-4} g mol/litre (*i.e.* 345 compared to $2 \times 170 = 340$ minutes). Similar results were also obtained with these same mixtures at different concentrations (*cf* 2,6-di-*t*-butyl-4-methyl phenol and phenyl-β-naphthylamine in Table III, the induction periods for the former at 2×10^{-3} and at 10^{-4} g mol/litre were 440 and 60 minutes respectively). Moreover, 2,4,6-tri-methyl phenol gives an induction period of 455 minutes with 2,6-di-*t*-butyl-4-methyl phenol, which is also more than twice as long as the induction period of the stronger inhibitor (tri-methyl phenol), *i.e.* 455 compared to $2 \times 185 = 370$ minutes. It must be concluded, therefore, that even under these apparently favourable conditions, hydrogen transfer processes can play no more than a minor role in promoting synergism and, by analogy, this will probably also be true of the other mixtures containing 2,6-di-*t*-butyl-4-methyl phenol. Moreover, mixtures which do not contain this phenol generally show smaller synergistic effects than those containing it, and therefore hydrogen transfer is probably not an important cause of synergism in any of the mixtures studied.

Another possible cause of synergism arises when a free radical inhibitor is also a strong peroxide decomposer, in which case its performance can frequently be improved by the addition of certain compounds that are completely ineffective by themselves.[18] These ineffective compounds apparently form a weak complex with the inhibitor and prevent it from reacting with peroxides although it is still able to react with free radicals.[18] In this way the inhibitor is conserved for its more useful role. Although this mechanism may contribute to synergism in the mixtures which do not contain 2,6-di-*t*-butyl-4-methyl phenol, this phenol is itself sterically so well protected it is unlikely to complex with the second component. Therefore, since this mechanism is not operative in the mixtures which show the greatest synergism it is probably not of major importance with the other synergistic mixtures.

It would appear therefore that the synergistic effects observed between two free radical inhibitors must be largely, or even entirely, due to peroxide decomposition by one of them. Any relation between synergism and the rates of peroxide decomposition is likely to show up most clearly in mixtures containing the strictly free radical inhibitor 2,6-di-*t*-butyl-4-methyl phenol. As was mentioned above, the relative rates of induced peroxide decomposition are derived from the slopes of the curves in Fig 2, but since these are not very accurate, the inhibitors have only been divided into classes with roughly equivalent rates. The true

synergistic effects increase in the following order for mixtures of this phenol and a second inhibitor (both at 5×10^{-4} g mol/litre). 4-Hydroxydiphenylamine (I) (0) < β-naphthylamine (II) (40) < 4-methylphenol (I) (50) < α-naphthylamine (II) (60) < phenyl-α-naphthylamine (II) (95) < 4-methoxyaniline (II) (115) < phenyl-β-naphthylamine (III) (125) < diphenylamine (I) (130) < 4-methoxyphenol (II) (145) < 2,4,6-tri-methyl phenol (III) (160). The numbers I, II, and III after each inhibitor refer to weak, intermediate, and strong classes of peroxide decomposer respectively, and the second number to the true synergistic effect. Inhibitors that were studied only at lower concentrations have not been included in this list.

Although most of the inhibitors which are weak or intermediate peroxide decomposers show less synergism than the strong decomposers, the expected correlation between these factors is certainly not very good. This may be due to the fact that, in the absence of steric effects, a weak peroxide decomposer is also a weak free radical inhibitor, since the rates of reactions (6) and (7) both depend on the same factor, *i.e.* on the availability of electrons at the reactive centre of the molecule.[11, 19, 20] Both a weak and a strong peroxide decomposer might therefore show equal synergistic effects with 2,6-di-*t*-butyl-4-methyl phenol, since a larger proportion of the latter would be destroyed by free radicals. This may explain why the induction periods quoted above for mixtures of this phenol with 4-methoxyaniline, diphenylamine, 4-methoxy phenol, phenyl-α- and phenyl-β-naphthylamine are very similar, even though the induction periods and rates of peroxide decomposition of the individual inhibitors are quite different. This similarity does not, however, extend to the mixtures containing very weak (*e.g.* 4-methylphenol, β-naphthylamine) or very strong (*e.g.* 2,4,6-tri-methyl phenol, 4-hydroxydiphenylamine) inhibitors. Some discrepancies may also be due to an underestimation of peroxide decomposition rates because of low inhibitor solubility, *i.e.* both 4-methoxyaniline and 4-methoxyphenol may be stronger peroxide decomposers than the partial curves in Fig 2 suggest. The occurrence of hydrogen transfer processes and cross-combination reactions between inhibitor radicals may also contribute to the discrepancies. For example, smaller synergistic effects are obtained with 2,4,6-tri-*t*-butyl phenol than with 2,6-di-*t*-butyl-4-methyl phenol, although both apparently react only with free radicals. It seems likely that this difference is connected with the reactivities towards peroxy radicals of the two phenoxy radicals. The radical derived from the former compound is much less reactive than that from the latter,[11] which means that under the same conditions in an autoxidizing system its concentration will be greater. This radical is therefore more likely than the 2,6-di-*t*-butyl-4-methyl phenoxy radical to undergo cross-combination reactions with the radical derived from the second inhibitor:

$$A^{\cdot} + I^{\cdot} \longrightarrow AI \quad . \quad . \quad . \quad . \quad (13)$$

e.g. the second step in reaction (11). The reactions by which each inhibitor molecule traps its second peroxy radical are therefore suppressed and the inhibiting power of the mixture is decreased. As a result, the synergistic effects obtained with 2,4,6-tri-*t*-butyl phenol are smaller than with 2,6-di-*t*-butyl-4-methyl phenol and may even disappear (*e.g.* with 2,4,6-trimethyl phenol there is true antagonism (−30 minutes)). Reaction (13) probably also occurs with other inhibitor mixtures. Provided its rate is greater than the rates of the two self-combination reactions, *i.e.*

$$I^{\cdot} + I^{\cdot} \longrightarrow I_2 \quad . \quad . \quad . \quad . \quad (14)$$

the inhibiting power of the mixture will decrease and, if the effect of reaction (13) is greater than that of the factors promoting synergism, the two inhibitors will be mutually antagonistic.

The anomalously large synergistic effect found between 2,6-di-*t*-butyl-4-methyl phenol and the very weak peroxide decomposer diphenylamine (130 minutes) may be due to special causes, since it has been suggested[17] that this amine reacts with peroxy radicals by at least two paths, one of which leads to primary products that are themselves inhibitors.[21]

Ivanov and Vilyanskaya[22] have suggested that phenyl-β-naphthylamine, diphenylamine, and 4-hydroxydiphenylamine react solely with R˙ radicals and do not react with peroxy radicals or hydroperoxides. The results in Fig 2 and Table II show that these inhibitors can all react with peroxides under the present conditions and apparently have little in common. Moreover, the synergism found with 2,6-di-*t*-butyl-4-methyl phenol and the first two inhibitors (*i.e.* 80 and 130 minutes respectively) cannot be due to their reaction with R˙ radicals, since the overall result would be the same as if they reacted with peroxy radicals, a process which leads to additivity (*cf* 2,6-di-*t*-butyl-4-methyl phenol and 2,4,6-tri-*t*-butyl phenol). The absence of synergistic effects with the strong inhibitor 4-hydroxydiphenylamine suggests that it reacts so rapidly with R˙ or RO_2˙ radicals that none of it is destroyed by peroxide, and the very small minimum in its peroxide decomposition curve suggests that it is not particularly active towards RO˙ or ˙OH radicals. This inhibitor was also exceptional in that no mixtures containing it showed synergistic effects, the results being always additive or antagonistic.

Since aliphatic amines give some free radicals on reaction with *tert*-butyl hydroperoxide,[23] it might be expected that they would catalyse the oxidation of the oil. Even a very small catalytic effect would probably be quite noticeable as antagonism of the inhibition produced by 2,6-di-*t*-butyl-4-methyl phenol. However, this reaction must be comparatively unimportant

under the present conditions during the induction period, since the following amines at 5×10^{-4} g mol/litre are all inactive, both by themselves and with this phenol at this concentration: *n*-hexadecylamine, tri-*n*-heptylamine, N,N-diethyl-α-naphthylamine, N-methyl diphenylamine, and triphenylamine. On the other hand, di-*n*-heptylamine, although inactive by itself, gives a 20-minute synergistic effect with the phenol. This amine and the other two alkyl amines are all very strong peroxide decomposers, whereas the tertiary alkaryl amines and triphenylamine are rather weak decomposers. If the synergistic effect of di-*n*-heptylamine is due to hydroperoxide decomposition by the amine, few free radicals can be formed, *i.e.* decomposition to non-radical products must far outweigh the antagonistic effect of radical production. It is surprising that the other two alkyl amines do not show similar effects. However, the fact that the amines are all inactive by themselves suggests that the synergism of di-*n*-heptylamine with 2,6-di-*t*-butyl-4-methyl phenol may be due to hydrogen transfer to the phenoxy radical, since the hydrogens on the α-carbon atoms of aliphatic amines are quite easily removed by free radicals.[23]

Two non-hindered inhibitors that can both act as peroxide decomposers and as free radical inhibitors would be expected to give true synergistic effects in combination. However, in addition to the several factors that tend to disguise any obvious relation between the rate of peroxide decomposition by an inhibitor and its synergism with a hindered phenol, there is also the possibility that non-hindered inhibitors may complex with one another. Such a complex would probably be less reactive towards peroxy radicals than the free inhibitors, and might contribute towards antagonism, even though only a small proportion of the inhibitors could be complexed under the present experimental conditions.

Complex formation has been suggested previously to account for the antagonism of 4-methylphenol and 2,4-dimethylaniline.[7] In this case some complexing was shown to occur at room temperature by infra-red measurements and was attributed to the acidic and basic properties of the two inhibitors. Complexes between many amines and phenols in inert solvents have also been detected by other workers.[24–26] The results in Table II suggest that although some of the cases of antagonism might be due to this cause (*e.g.* perhaps phenyl-α-naphthylamine with 4-methoxy phenol (−45) or 4-methylphenol (−35)), most of the other examples seem unlikely to fall into this category. Several of the antagonistic combinations suggest, in fact, that the reactive centres of the individual inhibitors are sterically too well protected to form complexes (*e.g.* 2,2′-methylene-bis (6-*t*-butyl-4-methyl phenol) with N,N′-di-*sec*-butyl-*p*-phenylenediamine (−30); 2,4,6-tri-methyl phenol with phenyl-α-naphthylamine (−15) etc.). Moreover, the mutual antagonism between amines (*e.g.* phenyl-α-naphthylamine and N,N′di-*sec*-butyl-*p*-phenylenediamine (−15)) and between phenols (*e.g.* α-naphthol and 2,2′-methylene-bis (6-*t*-butyl-4-methyl phenol) (−30)) is rather difficult to account for on the basis of complex formation. Although hydrogen transfer from the stronger inhibitor to the weaker inhibitor radical would give rise to antagonism, it is also unlikely to be of major importance, since the stronger inhibitor will tend to be consumed first. On the whole, the chief cause of antagonism under the present experimental conditions is probably the cross-combination reaction between inhibitor radicals, except possibly with mixtures containing a fairly strongly acid phenol and a rather basic amine.

The results for the remaining non-antagonistic mixtures show a rough correlation with the results obtained with 2,6-di-*t*-butyl-4-methyl phenol after allowance is made for the fact that the inhibitors replacing this phenol are themselves peroxide decomposers. For example, 2,2′-methylene-bis (6-*t*-butyl-4-methyl phenol) is, on a molar basis, a peroxide decomposer of intermediate strength. However, the concentration at which it was employed in the mixtures is only one-third the concentration of the other inhibitors, and it will therefore behave as a relatively weak decomposer. Mixtures containing this inhibitor therefore give somewhat smaller, but otherwise similar, synergistic effects to those obtained with the highly hindered phenol, the only exceptions being antagonism by α-naphthol (−30), 4-hydroxydiphenylamine (−40), and N,N′-di-*sec*-butyl-*p*-phenylenediamine (−30). Similar, though generally even smaller, synergistic effects were obtained with α-naphthol, since it also will behave as a relatively weak peroxide decomposer compared to the other inhibitors which were used at ten times its concentration. Phenyl-α-naphthylamine and diphenylamine are also weak decomposers, and they therefore show quite noticeable synergistic effects with many other inhibitors. This synergism is generally more pronounced with the former amine, possibly because it is a stronger free radical inhibitor than the latter. On the other hand, 2,4,6-tri-methyl phenol is a strong peroxide decomposer, and only shows large synergistic effects with strong free radical inhibitors that also happen to be weak peroxide decomposers, *e.g.* 2,6-di-*t*-butyl-4-methyl phenol and 2,2′-methylene bis (6-*t*-butyl-4-methyl phenol).

In conclusion, the most probable reason for the synergistic effects appears to be that one inhibitor functions primarily as a peroxide decomposer and the other as a free radical trap, although this suggestion still leaves several problems unanswered. Regeneration of the stronger inhibitor by hydrogen transfer and also its protection from side reactions by the formation of association complexes are relatively unimportant with the combinations of inhibitors which show the greatest synergism. These mechanisms are therefore

unlikely to be major contributors towards the synergism of other inhibitor combinations. True antagonism, numerically, rarely amounts to more than 10 per cent of the calculated induction period. Although antagonism may occasionally be due to the formation of an association complex between inhibitors, it is probably more generally due to a cross-combination reaction between inhibitor radicals. Additivity, where it is not due to a balancing of synergistic and antagonistic effects, probably results from both inhibitors reacting by a single process.

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SEPARATION, INVESTIGATION, AND REFINING OF LUBRICATING OILS IN MIXED BASE UAR CRUDE OILS

PART I. EVALUATION OF LUBRICANTS IN MAIN UAR CRUDE OILS*

By M. A. BORHAM† and Prof. A. MUSTAFA‡

INTRODUCTION

THE object of this research is to evaluate the lubricating oil content, to determine its composition in the main crude oils produced in UAR, and to select the crude which can be considered most suitable for the manufacture of lubricating oils.

SELECTION OF CRUDE OILS FOR EVALUATION

From a survey of UAR oilfields,[1] three fields only are considered to have a relatively high production, and each can feed a lubricating oil plant which can produce lubricants needed by UAR. These fields are Belayim, Ras Gharib, and Rudeis.

INVESTIGATION OF CRUDE OILS

40 gallons of crude oil were taken from each field in March 1959 and their physical and chemical characteristics were determined (Table I). Testing methods used are after those published by the IP.[2] The three crudes are black in colour and have a relatively high sulphur content, which is objectionable,[3] but it must be mentioned that refineries are now driven to the use of higher and higher sulphur content stocks.[4] They also have a high percentage of asphaltenes as determined according to IP 143/57, using *n*-heptane. After separation of asphaltenes, resins and wax were determined in a deasphalted sample using similar methods to those described in Part IV, No. 2, but a 10-g sample was used.

Results of the evaluation of asphaltenes, resins, and paraffins are shown in Table I. It is noticed that the three crudes belong to the "mixed base type," containing asphalt and paraffin, but in varying amounts. Belayim crude contains the highest percentage of asphaltenes, 13·7 per cent, while the other two crudes contain about the same percentage, 8·75 per cent for Rudeis crude and 8·5 per cent for Gharib crude.

The three crudes contain paraffin wax, Rudeis crude having the highest amount, 6·2 per cent, while it is 4·9 per cent for Gharib crude and 4·6 per cent for Belayim crude.

Belayim crude has the highest percentage of silica gel resins, amounting to 17·5 per cent, while it is 14 per cent for Gharib crude and 13·75 per cent for Rudeis crude.

Asphaltenes, paraffins, and resins are very objectionable in lubricating oils.

TABLE I

Characteristics of Crude Oils

Test	Belayim crude	Gharib crude	Rudeis crude
Specific gravity at 15/4° C	0·9288	0·9004	0·9051
API gravity at 60° F	20·84	25·65	24·85
Water, % vol	0·05	0·1	0·05
Salt, % wt	0·02	0·015	0·005
Pour point, ° F	40·00	36·00	42·00
Viscosity Red. I at 100° F sec	654·0	122·0	182·0
Sulphur content, % wt	3·0	2·92	2·2
Carbon residue, Conradson, % wt	14·9	9·42	10·15
Hard asphalt, % wt	13·7	8·5	8·75
Paraffin wax, % wt	4·6	4·9	6·2
Silica gel resins, % wt	17·5	14·0	13·75
Ash content, % wt	0·036	0·028	0·025
Distillation:			
% recovered at—			
100° C	—	4	3·0
125° C	2·5	7·5	7·0
150° C	6·0	12·0	11·0
175° C	9·5	15·5	15·0
200° C	14·0	19·0	18·0
225° C	17·5	23·0	22·0
250° C	21·0	26·5	26·0
275° C	25·0	31·0	29·5
300° C	28·0	36·0	36·0

DETAILS OF SEPARATION OF LUBRICATING OILS

For separation of the lubricant fraction in the crude oils tested, the following operations were carried out.

1. A crude oil sample was distilled under atmospheric and vacuum pressures to separate light non-lubricating fractions.
2. From the remaining residuum, asphaltenes were removed by precipitation with *n*-heptane,

* MS received 17 February 1961.

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TABLE II

Breakdown of Crude Oils Tested

Fraction no.	Temp, ° C		Pressure, mm Hg	Vapour temp at 760 mm Hg	Product weight		Yield, %		Sp gr at 15/4 °C	Aniline point, ° F	Visc kin at 100° F	Refractive index n_D^{20}
	Still	Vapour			Per cut, g	Total wt, g	Per cut	Sum				
					I. Belayim Crude Oil—Charge 2785 g							
1	251	150	760	150	196	196	7·1	7·1	0·7095	—	0·58	1·4026
2	292	200	760	200	116	312	4·2	11·3	0·7805	139·6	1·00	1·4341
3	185	125	15	250	96	408	3·4	14·7	0·8110	143·2	1·5	1·4498
4	224	165	15	300	161	569	5·8	20·5	0·8470	147·5	2·3	1·4641
5	268	205	15	350	213	782	7·6	28·1	0·8630	157·0	4·45	1·4787
	Residue				1977	2759	71·0	99·1	—	—	—	—
	Gas and loss				26	2785	0·9	100·0	—	—	—	—
	Total				2785	2785	100·0	100·0	—	—	—	—
					II. Gharib Crude Oil—Charge 2610 g							
1	233	150	760	150	245	245	9·4	9·4	0·7195	—	0·58	1·4072
2	292	200	760	200	160	405	6·1	15·5	0·7880	134·2	1·00	1·4385
3	180	125	15	250	110	515	4·2	19·7	0·8175	139·0	1·54	1·4550
4	220	165	15	300	205	720	7·8	27·5	0·8410	148·0	2·47	1·4681
5	260	205	15	350	220	940	8·4	35·9	0·8660	161·0	5·10	1·4819
	Residue				1640	2580	63·0	98·9	—	—	—	—
	Gas and loss				30	2610	1·1	100·0	—	—	—	—
	Total				2610	2610	100·0	100·0	—	—	—	—
					III. Rudeis Crude Oil—Charge 2565 g							
1	232	150	760	150	220	220	9·5	9·5	0·7185	—	0·6	1·4047
2	290	200	760	200	150	370	5·0	14·5	0·7805	139·0	1·1	1·4342
3	185	130	20	250	122	492	4·6	19·1	0·8130	143·5	1·52	1·4521
4	232	165	15	300	175	667	6·8	25·9	0·8370	151·2	2·55	1·4665
5	278	205	15	350	210	877	8·2	34·1	0·8640	163·0	5·30	1·4805
	Residue				1662	2529	65·0	99·1	—	—	—	—
	Gas and loss				26	2565	0·9	100·0	—	—	—	—
	Total				2565	2565	100·0	100·0	—	—	—	—

resins were separated by adsorption on silica gel,[5,6] and paraffin waxes were then separated from deasphalted de-resined oil by solvent dewaxing.

3. Dewaxed oil was chromatographically fractionated[7-10] into ten fractions by using silica gel and three selective eluents, and the potential content of lubricants was determined by cumulative blending of these fractions and testing of their properties.

For these operations, the following chemicals* were used: *n*-heptane, ethyl alcohol, benzene, toluene, methyl ethyl ketone (MEK), petroleum ether, boiling range 40°–60° C. Silica gel, diameter 0·2–0·5 mm, activated by heating to 400° C.

The detailed procedures for these evaluations are now described.

(1) *Atmospheric Vacuum Distillation*

Light fractions from crude oil samples were distilled in an apparatus consisting of a 5-l flask having a thermometer well. It is connected by ground joint to a Pyrex glass column 45 mm dia, 20 inches long, and packed with metallic nickel chrome coils 1 cm long and 5 mm diameter. The column has a top Claisen head with reflux condenser and is connected to a water condenser. Fractions were collected at atmospheric pressures up to 200° C, then distillation was stopped for cooling and restored under vacuum at pressure of 15 mm Hg. Fractions were then collected up to vapour temperature equivalent to 350° C at atmospheric pressure. The main physical properties were determined for different fractions (Table II).

(2) *Deasphalting, De-resining, and Dewaxing of Residues*

(*a*) Separation of asphaltenes from residues was carried out by using *n*-heptane,[11] according to procedure described in IP 143/57. Two 100-g samples of residuum were each warmed with 2 litres of petroleum ether and allowed to stand overnight in a dark place. Precipitated asphaltenes were removed by filtration, washed, dried, and weighed.

(*b*) Filtrates from (*a*) were distilled to reduce the petroleum ether content to about 20 per cent. About 800 g of silica gel were added to reduced filtrate of each sample; the mixture was well agitated and

* Analar Chemicals (Merck Co) were used.

heated under reflux using a long air condenser, until the colour of petroleum ether became pale yellow. The mixture of oil and silica gel was then transferred to three Soxhlet extraction apparatuses, each having a capacity of 400 g (Fig 1). Each extractor was fixed to a 1-l flask containing 600 ml of petroleum ether which was cycled in Soxhlets for about 16 hours, or until the solvent dropping from each extractor did not leave any stain on vaporization of a drop on a watch glass. The petroleum ether solutions of oil and paraffin in flasks were reduced by distilling in nitrogen atmosphere and then weighed.

(*c*) Resins, adsorbed by the silica gel, were removed by cycling a 50/50 solution of benzene–ethyl alcohol

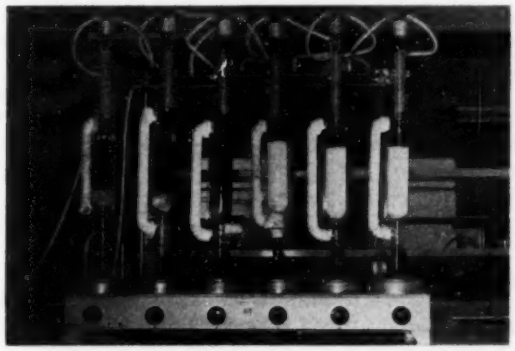

FIG 1

SOXHLET EXTRACTORS

Silica gel in the three right extractors is deresined.

in the Soxhlets for about 10 hours. Resin solutions were then reduced on a water bath in nitrogen atmosphere, and the resins were weighed.

(*d*) Waxy oil samples from step (*b*) were dewaxed at low temperature using solvents.[12-14] A mixture of benzene, MEK, and toluene (50 : 40 : 10) was used. 100 g of waxy oil were primarily heated on a water bath to 60° C, then the mixture of solvents was added in the ratio of 4 : 1 by weight. Solvent–oil mixture was heated to 50° C with continuous agitation, then left to cool to room temperature. It was then cooled gradually in an ice water bath, followed by an alcohol–dry ice bath, at a rate of 25°–30° C/hour, until the temperature of −25° C was attained. Crystallized paraffins were separated by cold filtration and washed with cold solvent mixture. Both wax cake and oil filtrate were reduced on a steam plate in nitrogen atmosphere, then the wax and oil were weighed.

Percentage of asphaltenes, resins, and wax, together with analysis of separated lubricating oil stocks, are given in Table III.

Comparing residues from the three indigenous crudes, the following is noticed.

Rudeis residue has the lowest percentage of silica gel resins, 21·6, compared with 23 for Gharib and 24 for Belayim. Extracted resins have different consistencies, they are semi-solid in Rudeis and solid in the other two residues.

TABLE III

Deasphalting, De-resining, and Dewaxing of some Egyptian Residues

Test	Rudeis residue	Gharib residue	Belayim residue
I. Residuum Properties			
Yield from crude, % wt	65	63	71
Specific gravity at 15/4° C	0·9820	0·9770	0·9910
API gravity at 60° F	12·59	13·33	11·29
Flash point, C.O.C., ° F	435	425	450
Viscosity Redwood II at 210° F	639	435	1290
Conradson carbon, % wt	13·2	12·4	17·8
Sulphur content, % wt	2·57	3·15	3·4
II. Yield from Residuum			
Asphaltenes (IP 143/57), % wt	14·0	13·6	19·5
Silica gel resins, % wt	21·6	23·0	24·0
Consistency of resins	Semi-solid	Solid	Solid
Slack wax, % wt	15·4	14·0	12·5
Dewaxed lube oil, % wt	49·0	49·4	44·0
III. Yield Based on Crude			
Asphaltenes (IP 143/57), % wt	9·1	8·5	13·85
Silica gel resins, % wt	14·00	14·5	17·05
Slack wax, % wt	10·00	8·8	8·90
Dewaxed oil, % wt	31·90	31·2	31·20
IV. Dewaxed Oil Properties			
Specific gravity at 20/4° C	0·9469	0·9398	0·9489
Viscosity kinematic, cS at—			
100° F	311	205	317
122° F	141	98·6	142
140° F	82·5	61·0	82·5
210° F	18·1	14·5	17·8
Viscosity index	+61	+64	+54·7
Refractive index n_D^{20}	1·5258	1·5242	1·5304
VG constant	0·8932	0·8880	0·8970
Pour point, ° F	0	+5	0
Melting point of wax, ° F	138	146	137
Sulphur content, % wt	2·65	2·80	3·45

Belayim residue has the highest percentage of asphaltenes, 19·5, compared with 13·6 and 14 for Gharib and Rudeis respectively.

Rudeis residue has the highest percentage of slack wax, 15·4, compared with 14 and 12·5 for Gharib and Belayim respectively.

Dewaxed lubricating oil content is lowest in Belayim residue, being 44 per cent, compared with about 49 per cent for both Rudeis and Gharib.

Comparing properties of the lubricant fraction separated from the different residues, it is noticed that Rudeis and Belayim have about the same kinematic viscosity at 210° F, 18·1 and 17·8 respectively, compared with 14·5 for Gharib. Rudeis and Gharib oils have a high viscosity index of +61 and +64 respectively, compared with 54·7 for

Belayim. Higher VI of Gharib oil may be attributed to its higher pour point, which is 5° F, compared with 0° F for the other two oils. Sulphur content is lowest in Rudeis, being 2·65 per cent compared with 2·8 for Gharib and 3·45 in Belayim.

Taking sulphur content in crudes and residues into consideration, it is evident that Rudeis residue is the most preferable for lubricating oil manufacture in UAR, followed by Gharib residue.

FRACTIONATION AND BLENDING OF LUBRICATING OILS

The composition of lubricating oils separated from the three Egyptian crude oils was determined by adsorption separation, using silica gel for adsorption.[15-20] Three selective eluents were used, namely, petroleum ether 40°–60° C, benzene, and benzene–ethyl alcohol mixture (1 : 1). An adsorption column 7·5 ft high, 35 mm diameter was used, which can handle 1000 g of silica gel.

The silica gel column was prepared and densed by tapping. Before the addition of the oil sample, the silica gel was washed with 1500 ml of petroleum ether to remove heat. 100 g of lubricating oil sample was dissolved in three volumes of petroleum ether and gradually introduced into the column. Desorption was carried out by successive feeding of eluting liquids as follows:

Petroleum ether	2000 ml
Benzene	1200 ml
Benzene–alcohol (1 : 1) . . .	600 ml
Petroleum ether	600 ml

Pure petroleum ether was first separated from the bottom of the column and used again after checking its refractive index. The liquids flowing afterwards were received in 200-ml capacity test tubes. Benzene was added as soon as the last part of the petroleum ether reached the silica gel surface, without letting air enter the bed of the adsorbent, followed by alcohol–benzene mixture. The latter solvent desorbs resinous materials which move downwards in the column as black coloured rings.

Solvent–oil mixture in separate fractions was reduced by heating and stripped with the help of nitrogen. To avoid spreading of fractions over a large number, strongly diluted neighbour fractions were poured together and distilled to finally obtain ten oil fractions of the initial 100-g sample. The oil fractions were then dried and weighed and percentage yield calculated. Fractions were tested, using IP standard methods.[2] Results are given in Table IV (*a*) for Rudeis oil.

Oil cuts were then blended in proportion to the yield, and properties of different cumulative blends were determined. Results are given in Table IV (*b*), and Fig 2.

GROUP HYDROCARBON COMPOSITION OF LUBRICATING OILS

Approximate determination of group hydrocarbon composition, based on values of refractive index and specific dispersion,[19-22] was carried out as follows:

1. Paraffin–naphthene hydrocarbons include all fractions having refractive index at 20° C of not more than 1·49 and specific dispersion of 103 max.

TABLE IV

Fraction no.	Yield, % wt	Refractive index n_D^{20}	Density at 20° C, g/ml	Kinematic viscosity at 100° F, *C*,	Kinematic viscosity at 210° F, *C*,	Viscosity index	Refractive dispersion at 20° C, $Nf - Nc$	Specific dispersion, $\frac{Nf - Nc}{d} \times 10^4$
				(A) Characteristics of Separate Fractions of Rudeis Lubricating Oils Boiling over 350° C				
1	10·31	1·4702	0·8545	39·2	6·5	126	0·0084	97·5
2	7·84	1·4729	0·8625	40·7	6·5	120	0·0090	103·5
3	10·34	1·4784	0·8713	55·0	7·7	112·5	0·0093	106
4	6·08	1·4959	0·9006	114·5	11·5	94·6	0·0104	115
5	9·37	1·5111	0·9256	137·5	12·7	91·0	0·0125	135
6	9·45	1·5294	0·9534	201·0	13·0	44·7	0·0148	155
7	10·93	1·5561	0·9854	380·0	17·5	32·2	0·0183	186
8	13·09	1·5738	1·0092	1600·0	38·8	24·0	0·0213	210
9	13·86	1·5932	1·0241	(7400·0)	74	−24·8	0·0254	249
10	8·73	Black	—	—	—	—	—	—
				(B) Characteristics of Blends				
Blend no.								
1	18·15	1·4718	0·8576	40·6	6·63	+125	0·7936	96
2	28·49	1·4795	0·8710	45·5	7·17	+123·5	0·809	102
3	34·57	1·4840	0·8780	54·8	8·00	+120·0	0·817	105·5
4	43·94	1·4905	0·8870	70·02	9·35	+117·0	0·8265	114
5	53·39	1·4965	0·8950	81·5	10·00	+110·0	0·835	123
6	64·32	1·5065	0·9120	100·0	11·10	+103·0	0·855	131
7	77·41	1·5141	0·9236	139·5	12·40	+ 85·5	0·866	141·5
8	91·27	1·5234	0·9384	209·0	15·30	+ 76·0	0·8825	161
9	100·00	1·5302	0·9480	311·0	18·10	+ 61·0	0·8925	168

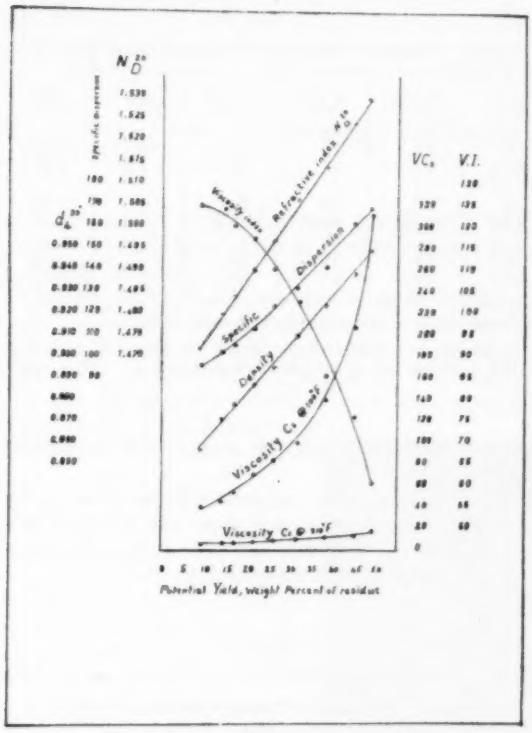

FIG 2

CHANGE IN THE QUALITIES OF RUDEIS LUBRICATING OILS (OVER 350° C) DEPENDING ON THE YIELD

2. Light aromatics include fractions with RI 1·49–1·53 and specific dispersion of not more than 150.

3. Medium aromatics include fractions with RI 1·53–1·59 and specific dispersion of not more than 200.

4. Heavy aromatics include fractions with RI higher than 1·59 and specific dispersion of +200.

5. Tars are the black coloured fractions separated by alcohol–benzene mixture.

By applying these principles to Rudeis oil, Table IV, the following can be concluded:

1. Fraction 1 is composed of paraffin–naphthene hydrocarbons (spec disp 97·5), and it has a very high viscosity index, 126.

2. Fractions 2 and 3 are composed mainly of paraffin–naphthene hydrocarbons and contain traces of aromatics (spec disp 106–103·5) and have high viscosity index (120–112·5).

3. Fractions 4 and 5 are composed mainly of light aromatics (spec disp 115–135) and have fairly high viscosity index (94·6–91).

4. Fractions 6 and 7 are composed mainly of medium aromatics (spec disp 155–186) and have low viscosity index (44·7–32·2).

5. Fractions 8 and 9 are composed mainly of heavy aromatics (spec disp above 200) and have very low or negative viscosity index (+24 to −24·8).

6. Tenth fraction is composed mainly of tars and resins.

It can be noticed that properties of different fractions correlate largely with group hydrocarbon composition. The first six fractions were eluted with petroleum ether and include paraffin naphthenes, light and some medium aromatics. Fractions 7–9 were eluted with benzene and are composed mainly of medium and heavy aromatics. Resins in fraction 10 were eluted with alcohol–benzene mixture.

The same analysis was carried on Gharib and Belayim lubricant fractions, from which it was found that both have the same characteristics as Rudeis, *i.e.* they contain paraffin–naphthenes of high viscosity index (+120), light aromatics of fairly high VI (+90), medium aromatics of low VI (+10 to +40), and heavy aromatics of negative VI. Therefore, indigenous crude oils are suitable raw materials for the

TABLE V

*Carbon Type Composition of Lubricating Oil Blends from Three Indigenous Crude Oils**

Blend no.	Refractive index, n_D^{20}	Density at 20° C, g/ml	Refractivity intercept	Molecular weight	Hydrocarbon group analysis		
					% CA	% CN	% CP
Rudeis Lubricating Oil Blends							
1	1·4718	0·8576	1·043	441	—	28	72
2	1·4795	0·8710	1·044	443	2	32	66
3	1·4840	0·8780	1·045	450	6	31	63
4	1·4905	0·8870	1·047	465	10	30	60
5	1·4965	0·8950	1·049	470	13	27	60
6	1·5065	0·9120	1·0505	440	16	28	56
7	1·5141	0·9236	1·0523	438	20	28	52
8	1·5234	0·9384	1·0542	442	24	28	48
9	1·5302	0·9480	1·0562	450	26	29	45
Gharib Lubricating Oil Blends							
1	1·4721	0·8573	1·0435	440	—	29	71
2	1·4740	0·8610	1·0435	444	—	31	69
3	1·4790	0·868	1·0450	447	4	30	66
4	1·4882	0·884	1·0460	470	8	29	63
5	1·4975	0·9000	1·0475	442	12	31	57
6	1·5071	0·9142	1·0500	439	16	29	55
7	1·5165	0·9270	1·0520	445	20	29	51
8	1·5200	0·9330	1·0535	442	22	28	50
9	1·5242	0·9398	1·0543	432	24	28	48
Belayim Lubricating Oil Blends							
1	1·4722	0·8563	1·044	440	—	28	72
2	1·4795	0·8702	0·0445	455	3	31	66
3	1·4882	0·8845	1·046	452	7	31	62
4	1·4970	0·8973	1·049	443	13	28	59
5	1·5033	0·9070	1·050	440	16	28	56
6	1·5114	0·9222	1·051	442	19	29	52
7	1·5185	0·9316	1·053	439	22	28	50
8	1·527	0·9468	1·054	445	24	29	47
9	1·5304	0·9489	1·056	440	26	28	46

* By density–refractivity intercept method, Kurtz, S. S., Jr, *et al.* *Analyt. Chem.*, 30.7.58.

TABLE VI

Hydrocarbon Group Analysis of Lubricating Oils Boiling over 350° C Separated from some Indigenous Crude Oils*

Name of lubricating oil	Blend no.	Density at 20° C	Refractive index, n_D^{20}	Molecular weight	% CA	% CN	% CP	% CR	RA	RT
Abu-Rudeis	1	0·8576	1·4718	440	2	28	70	29	>0·1	1·85
	9	0·9480	1·5302	448	26·0	27	47	54	1·2	3·9
Gharib	1	0·8573	1·4721	444	2	28	70	30	>0·1	1·95
	9	0·9398	1·5242	433	23·5	27·9	48·6	51·4	1·28	3·5
Belayim	1	0·8563	1·4722	442	2·0	28	70	30	>0·1	1·85
	9	0·9489	1·5304	440	26·0	27·0	47	53	1·4	3·7

* Using nomographs of van Nes–van Westen, "Aspects of the Constitution of Mineral Oils," Elsevier, 1951.

Notes. % CA = % carbon in aromatic structure. % CN = % carbon in naphthenic structure. % CP = % carbon in paraffinic chains. % CR = total % carbon in ring structure. RA = mean No. of aromatic rings/molecule. RT = mean total No. of rings/molecule.

manufacture of high grade lubricants by using the necessary refining methods to separate fractions composed of paraffin–naphthene and light aromatic hydrocarbons.

CARBON TYPE AND RING ANALYSIS

The structure of molecules in blends from the three lubricants was determined by two methods of ring analysis:

1. Kurtz, *et al* method,[22] using values of density and refractivity intercept, which was applied to all blends (Table V).

2. NDM method,[24] using values of density, refractive index, and molecular weight, and was applied to first and last blends of each of the tested oils (Table VI).

Results of the two methods correlate to a great extent, and the following can be concluded:

1. The blend of the first two fractions contains no aromatic compounds and is composed mainly of paraffin–naphthene hydrocarbons.

2. Aromatic content then increases gradually and at the same time paraffin content decreases, while the variation in the naphthene content is relatively small. As cyclization increases, values of density, viscosity, and refractive index increase, while viscosity index decreases.

CONCLUSION

From this research the following can be concluded:

1. Egyptian crude oils tested contain paraffin–naphthene and light aromatic hydrocarbons, which have particularly a high viscosity index, making them very suitable for the manufacture of lubricating oils by using suitable refining methods.

2. Rudeis crude is preferable, as it has lower sulphur and resinous content and a higher percentage of valuable high VI hydrocarbons as compared with other crudes.

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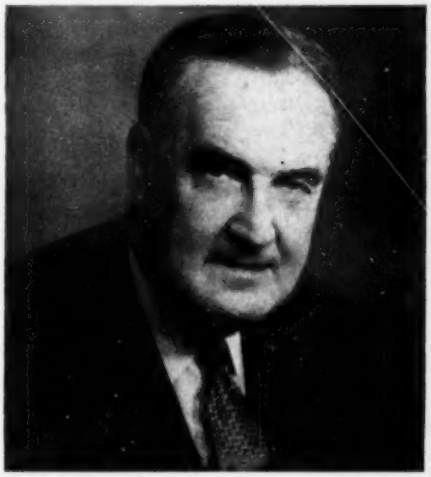
OBITUARIES

CHARLES MALCOLM VIGNOLES, C.B.E., M.A.

1901–1961

C. M. VIGNOLES, Immediate Past President of the Institute of Petroleum, died on 23 September, while on holiday in Italy.

Vignoles, or " V " as he was affectionately called by a host of friends in the oil industry, was educated at Sedbergh School and Magdalene College, Cambridge, whence he emerged with a degree in Mechanical Sciences. He joined the Shell group in 1924, serving first with the Asiatic Petroleum Company in Malaya until 1932, when he came to London to work in the Fuel Oil Department at St Helen's Court. He remained there until 1940, when he became the Shell representative on the Overseas Supply Committee of the Petroleum Board. Later on he became Joint Executive Secretary of the Committee, a key job in the vital task of ensuring the nation's wartime oil supplies. Legend credited him with more wartime Transatlantic journeys than any other businessman, and Lord Godber has paid tribute to the sterling qualities he showed during these years. His wartime services and devotion were recognized with the award of the O.B.E. in 1946.



From 1946 to 1950 he was Eastern Area Manager of the Shell group, joining the Board of Shell-Mex and B.P. Ltd in 1950 and becoming Managing Director in March 1951 until his retirement at the end of June 1961.

During these eventful years he guided Shell-Mex and B.P. in a period of great expansion, for the tonnage handled by the company more than doubled during this time. During this period, too, the remaining wartime controls were removed, as a result of determination and skill in negotiation in which " V " played a leading part. The company, moreover, itself underwent during these years fundamental organizational and operational changes.

Such tasks would have fully stretched many men. But " V " played a full part in wider activities in the industry. At the time of the Suez crisis in 1956 he was Chairman of the Oil Industry Emergency Committee, which assisted and advised the Minister of Power; he was made C.B.E. the following year. His Presidency of the Institute of Petroleum, from 1958 to 1960, coincided with the centenary of Drake's Well in 1959. With his wide contacts in the industry generally and his genial and warm-hearted personality, he made an excellent President. Many will recall his Presidential Address on " Petroleum People—Planning for Tomorrow."

" V " was a man with unusually wide interests outside the oil industry. He was Chairman of the Governors of Sedbergh School, Chairman of the Public Schools Appointments Bureau, Honorary Treasurer of the National Council of Social Services, a Council Member of the Royal Society of Arts, a Trustee of the Civic Trust, a Member of the Clean Air Council, a Past Master of the Worshipful Company of Turners, amongst many other appointments. He was especially interested in young people and education and had completed, just before leaving for his Italian holiday, the Institute of Directors report on the training of executives, for him a thoroughly congenial task.

It is not surprising to know that his retirement—tragically cut short almost as soon as it began—was to have been exceedingly active. He had been appointed Chairman of Evershed and Vignoles Ltd, the electrical engineers, of which his father had been Managing Director. He had become a Director of Remploy Ltd. And many other activities, too numerous to mention here, would have kept him busy.

T. W. M.

FREDERICK AINE TRIM
1901–1961

In business F. A. Trim, European representative, Universal Oil Products Company. To his many friends in the oil industry, Fred, reflecting the high esteem and great affection in which he was held. Always cheery, even during his final illness, the nature of which he knew. Always devoted to his friends, to whom he was ever ready to extend a helping hand, technical assistance, or a quiet word on behalf of someone temporarily unemployed. Devoted to duty with the interests of his company and its licensees ever at heart, a devotion which he maintained right up till his last few days.

Trained in the workshops of a motor firm towards the end of World War I, he established contact with the oil industry in 1919 as a draughtsman in the employ of a firm engaged in the design of petrol gas generators, petrol storage, and barrel washing plant. Thence he enlarged his knowledge of the oil industry with Cory Brothers, with the Medway Oil & Storage Co. Ltd, Isle of Grain, and with the Victoria Oil & Refining Co. Ltd, Kent. In 1925 he left for Havana, Cuba, to take up a post with the Compania Cuba de Electricidad Inc., where he remained for eight years. Returning to England, he was engaged, at the beginning of 1934, by the Universal Oil Products Company as a construction engineer. Abroad again on construction projects in France, Rumania, and Germany until 1939, when he was one of the last to leave Germany, a matter of hours before war broke out. He was engaged during the war years on work in connexion with the building of refineries for the manufacture of high octane aviation spirit, on loan on its termination to the U.S. Strategic Bombing Survey in Germany, and from 1945 to 1947 engaged in the rehabilitation and rebuilding of refineries on the Continent.

In 1947 he took over as European representative, Universal Oil Products Company, a post which he ably filled until his death.

He was long associated with the IP, joining as a Student Member in 1923 and becoming finally a Fellow, during which period he was instrumental in obtaining lecturers of high standing from his company.

Fred Trim will be missed by his many friends in the oil industry. He will, however, be ever remembered for his professional abilities, his human qualities, and the manner in which he faced up to his final illness.

J. S. P.

GUY BARR, B.A., D.Sc.
1885–1961

Dr Guy Barr was widely known in industry mainly because of his basic researches on the measurement of viscosity.

He assisted the IP on several of its technical committees. Barr's work on the viscosity of aeroplane dopes during World War I led to the development of U-tube viscometers for use at the National Physical Laboratory, the staff of which he joined in 1908. The design of these tubes was adopted by BSI, and since 1929 the calibration of such viscometers and of Redwood viscometers has been carried out in the Metallurgy Division, NPL. Reference tests of oil viscosity and tests incidental to lubrication work in the NPL have also been made there. Barr's Monograph of Viscometry (Oxford University Press) was printed in 1931. The current IP method of measuring the viscosity of liquid petroleum products by U-tube viscometers, which is technically equivalent to the current BS 188 method, bears the impress of Dr Guy Barr's patient, scholarly work. At the World Petroleum Congress organized by the Institute of Petroleum Technologists, held at the Imperial College of Science and Technology, South Kensington, July 1933, the measurement of viscosity was discussed at great length by well-known practitioners.

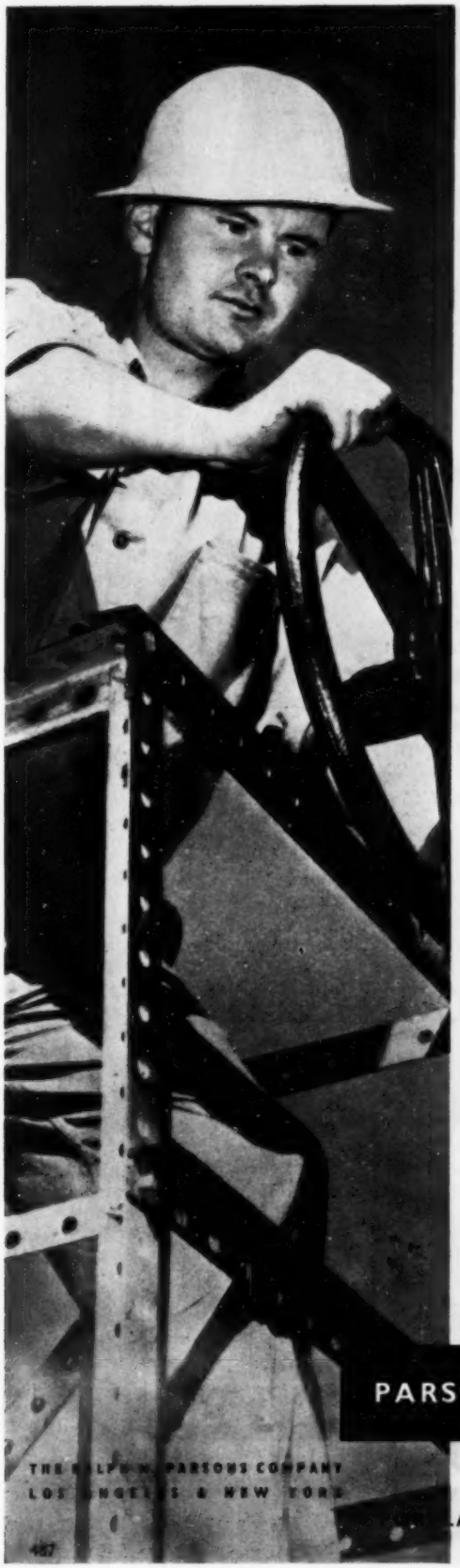
Their findings and general agreed conclusions bore fruit when, under the chairmanship of Guy Barr, until his retirement in 1950, the BS method was revised and subsequently rewritten after World War II. In 1946, when committee activities were resumed, Dr Barr laid down clearly in his draft revision the general principles of accurate viscosity measurement, making provision against errors due to surface effects, inertia, timing, etc.

He favoured the use of precision tubing then becoming available and preferred the use of a calibrated instrument rather than the use of a calibrated oil standard of known viscosity.

He dealt with the difficulty arising from requests for the "standardization" of special mechanical viscometers and plastometers by suggesting that their description and use be described in the specification for the special product for which they were required rather than in a specification dealing with the determination of viscosity.

Those of us who have worked closely with him realize the big contribution he has made in the rheological field and regret the loss of so congenial a colleague and friend.

E. W. G. M.



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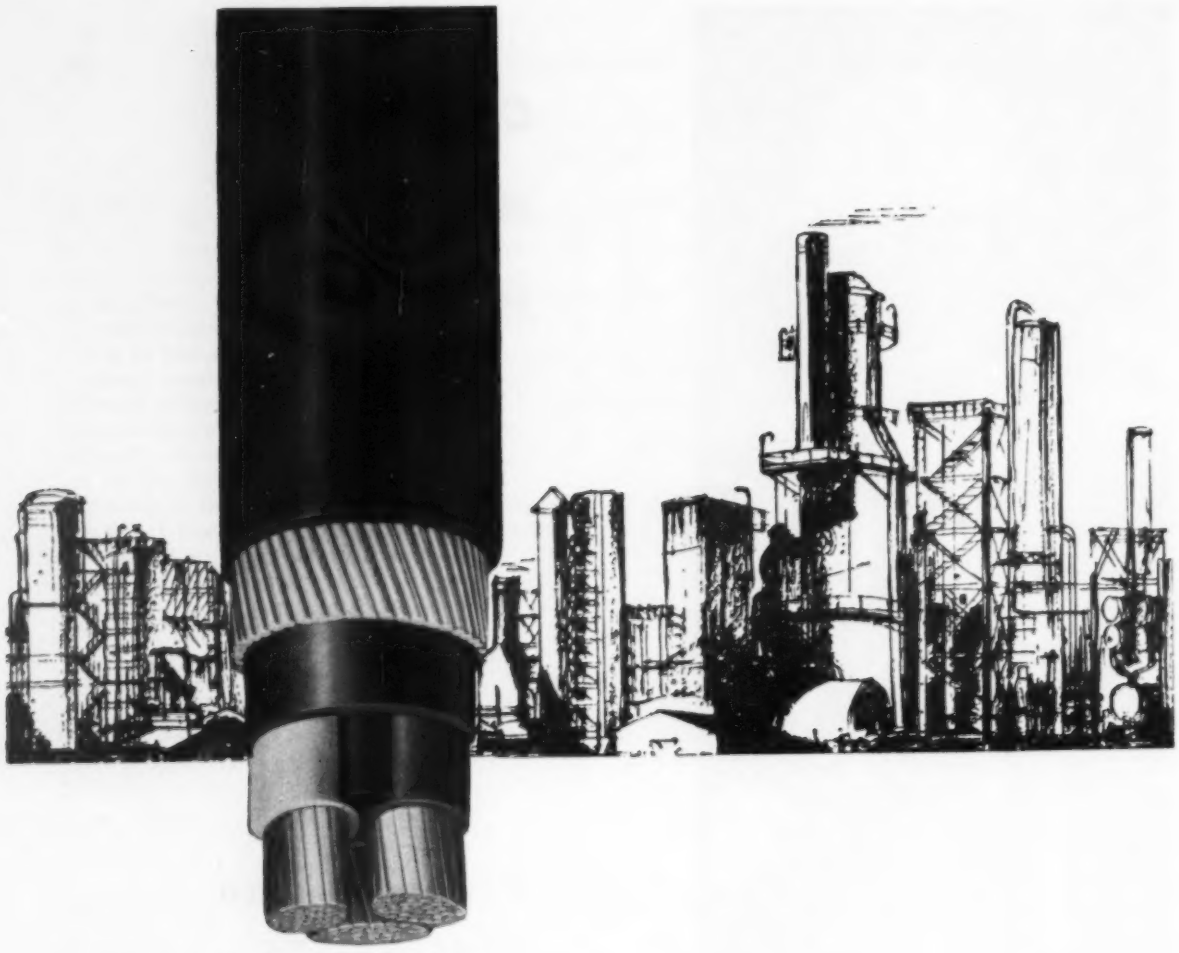

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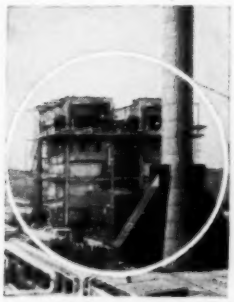

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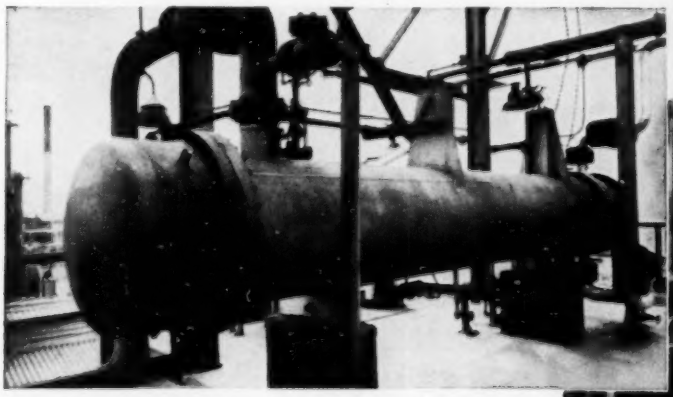
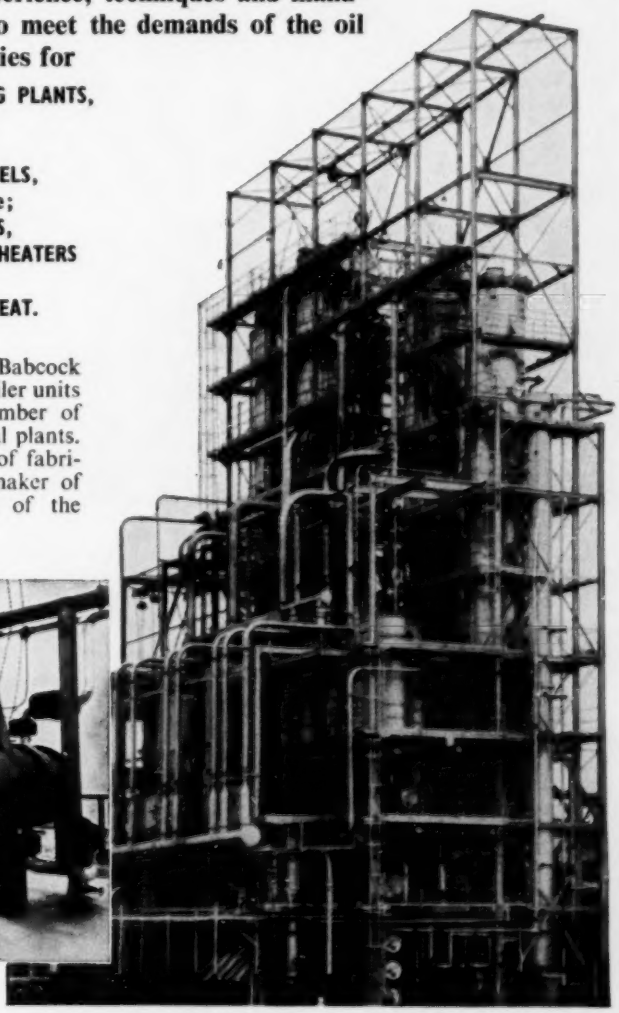


Heat-exchanger built by Babcock, in service at an oil refinery.



Distillation unit at an oil refinery, comprising Babcock fusion-welded columns.

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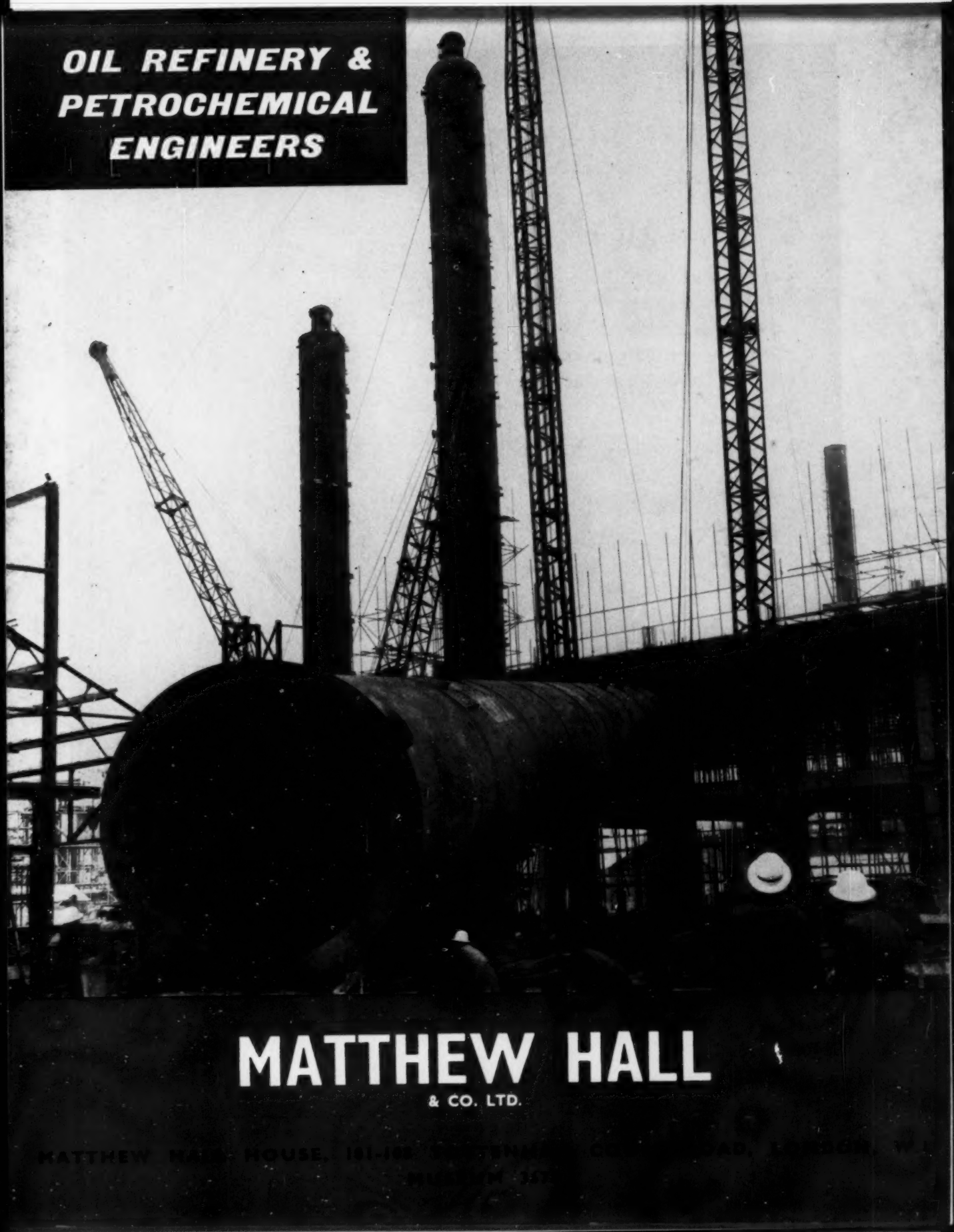
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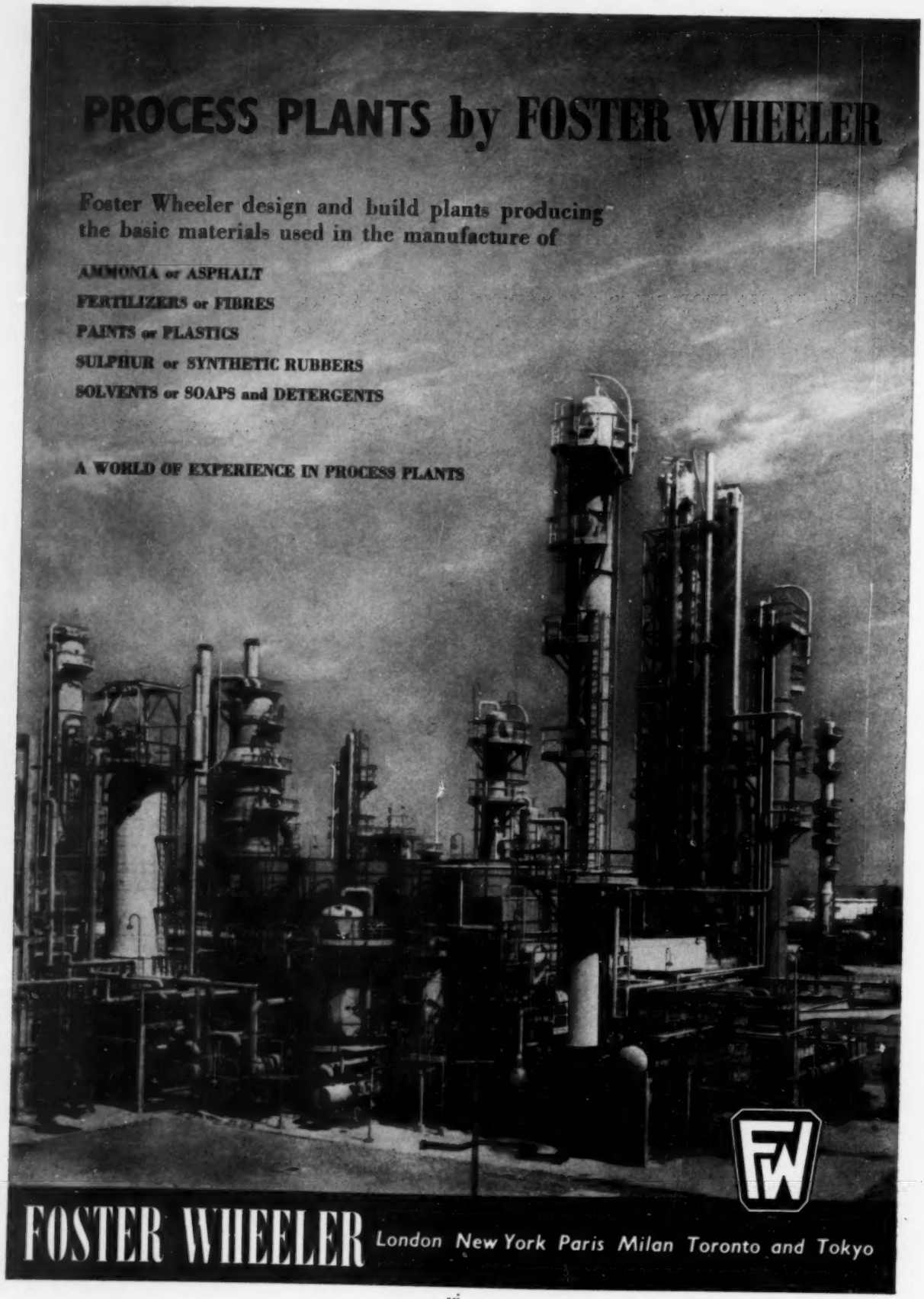
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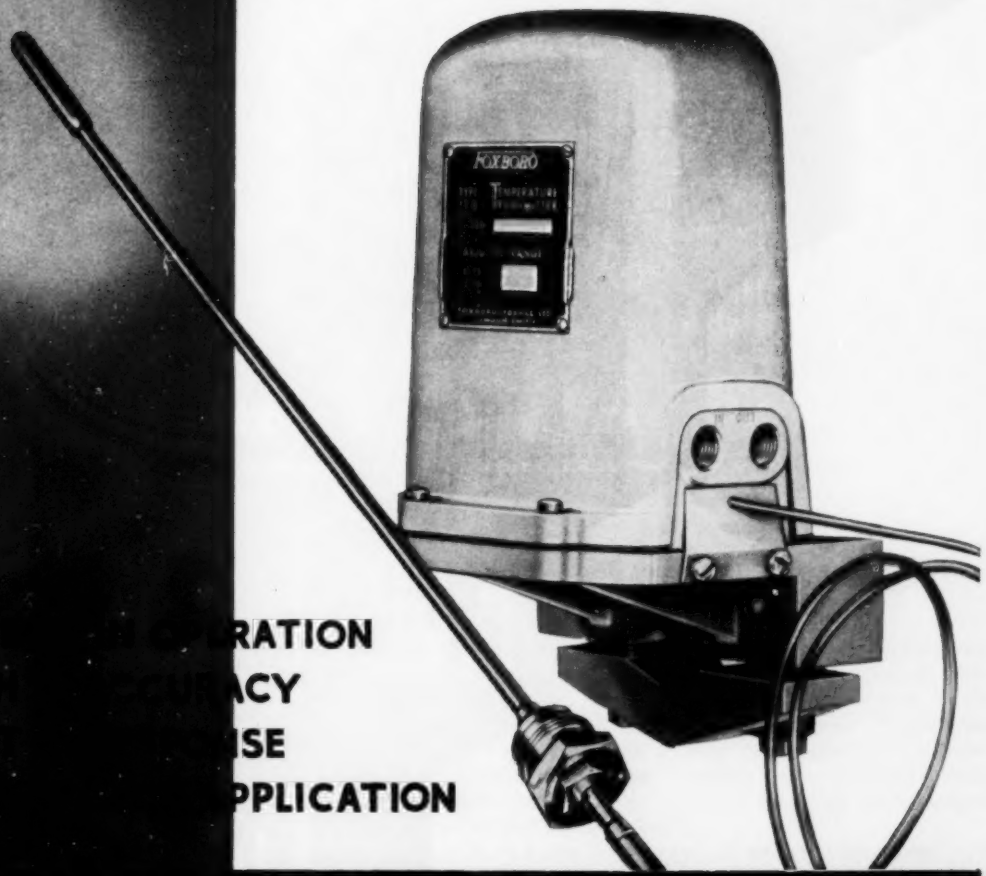

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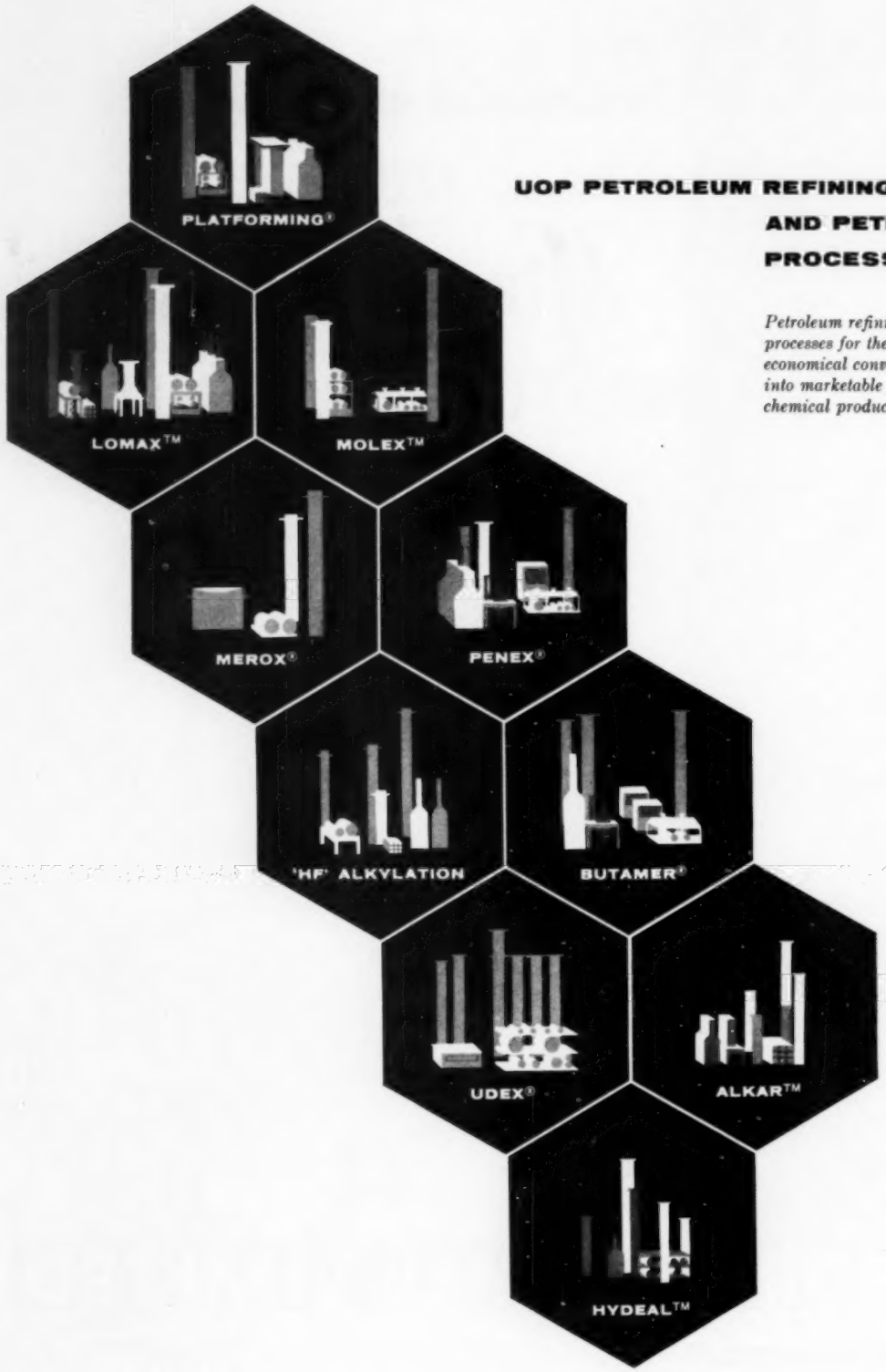

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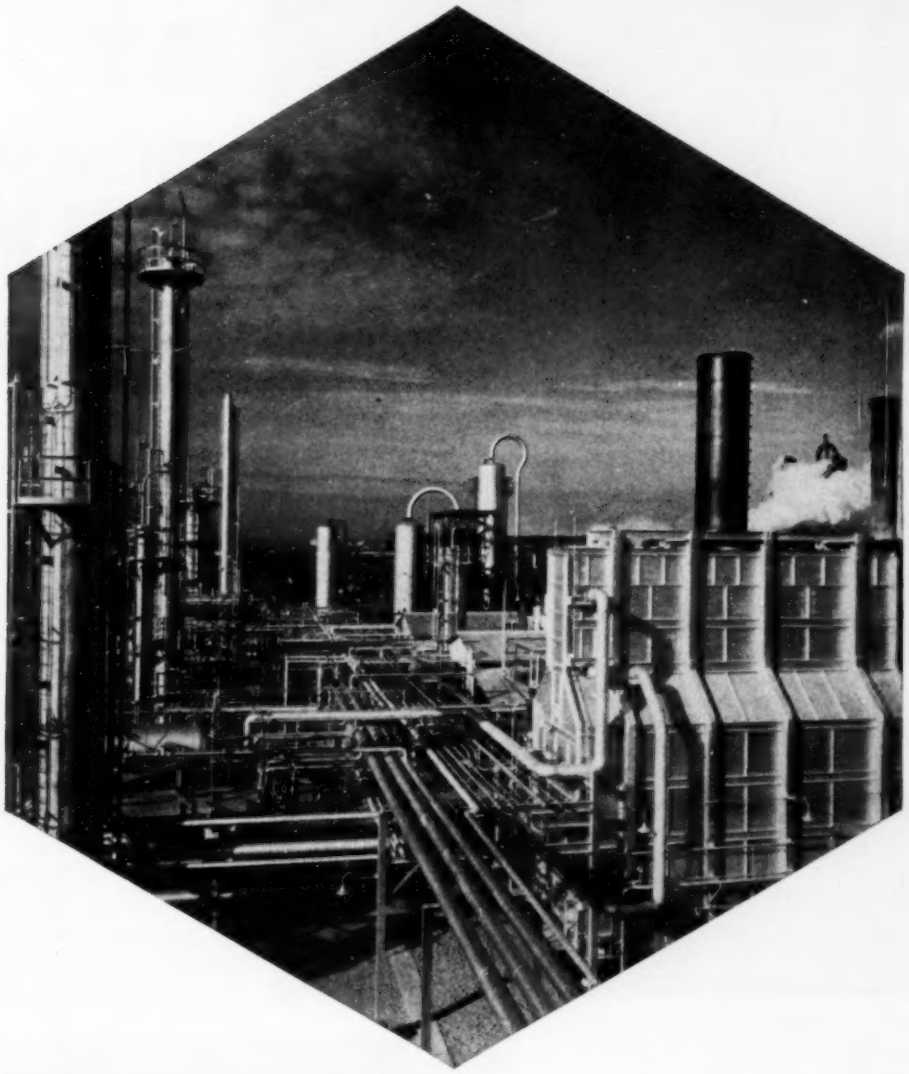

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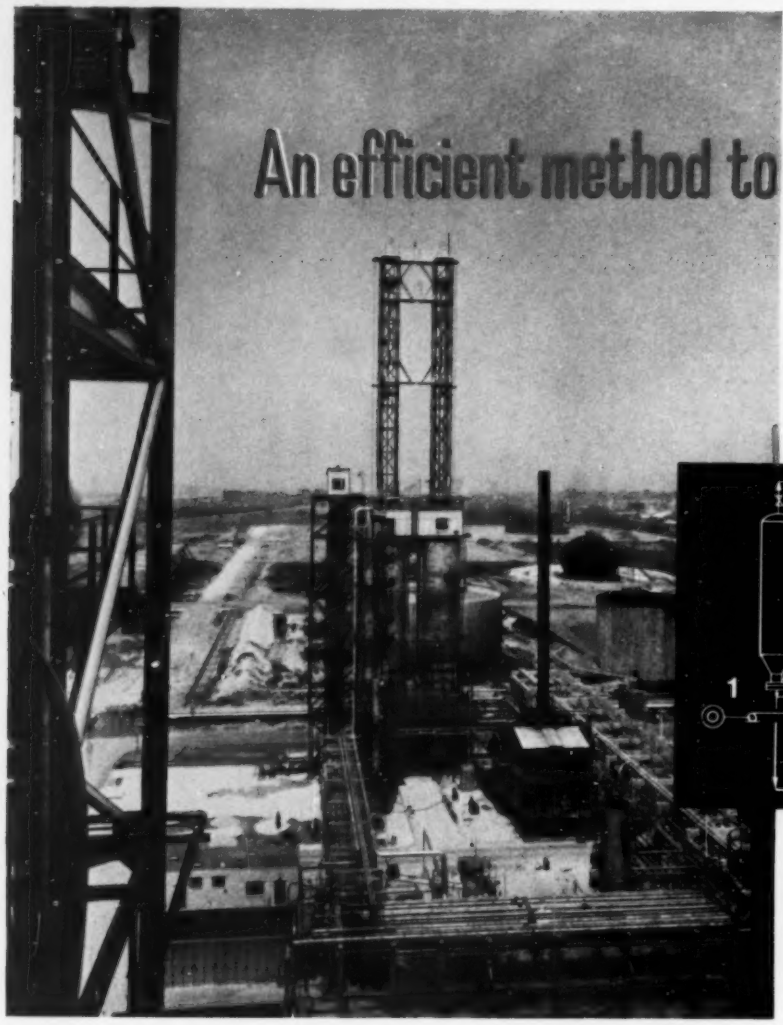

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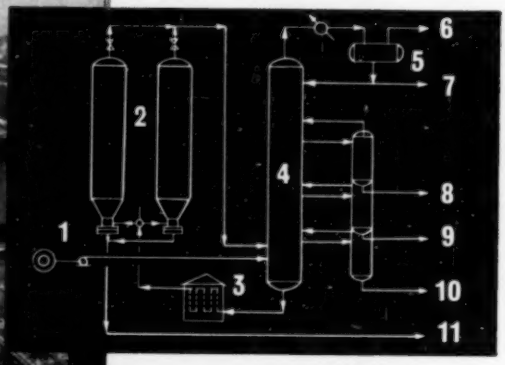

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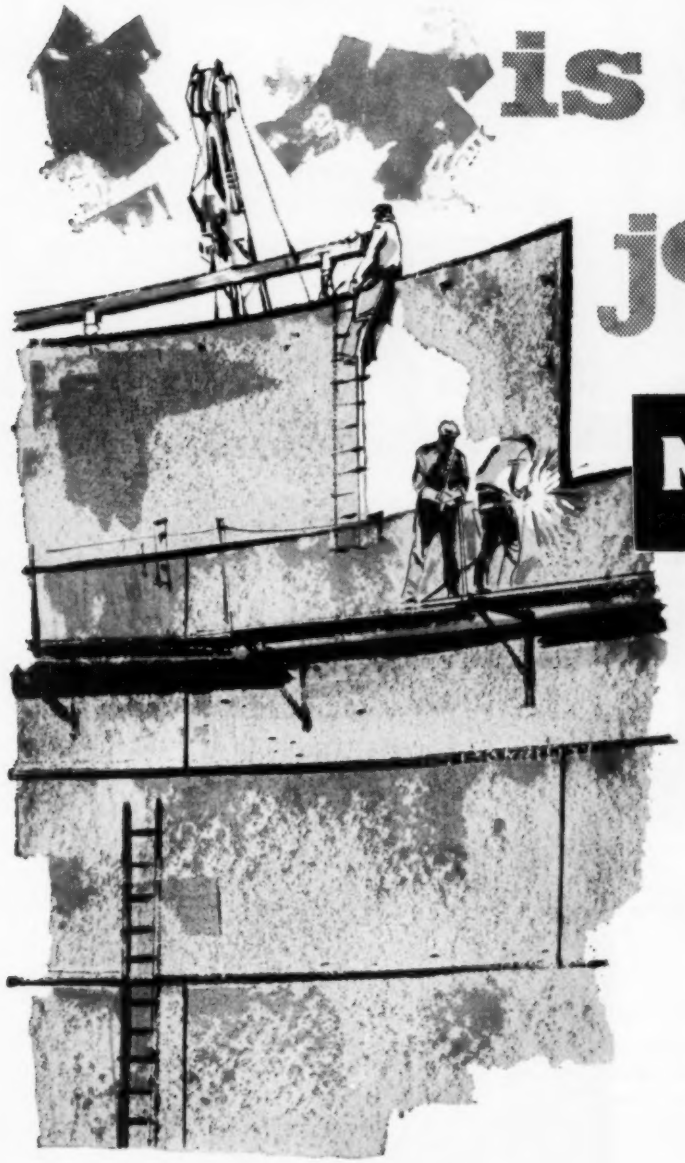

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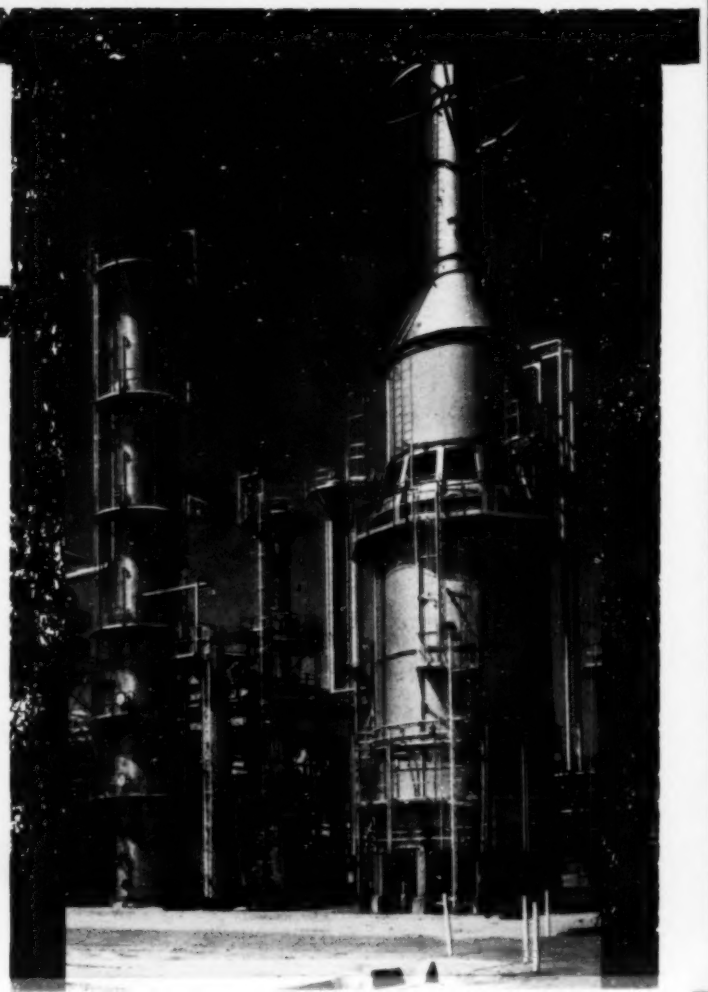

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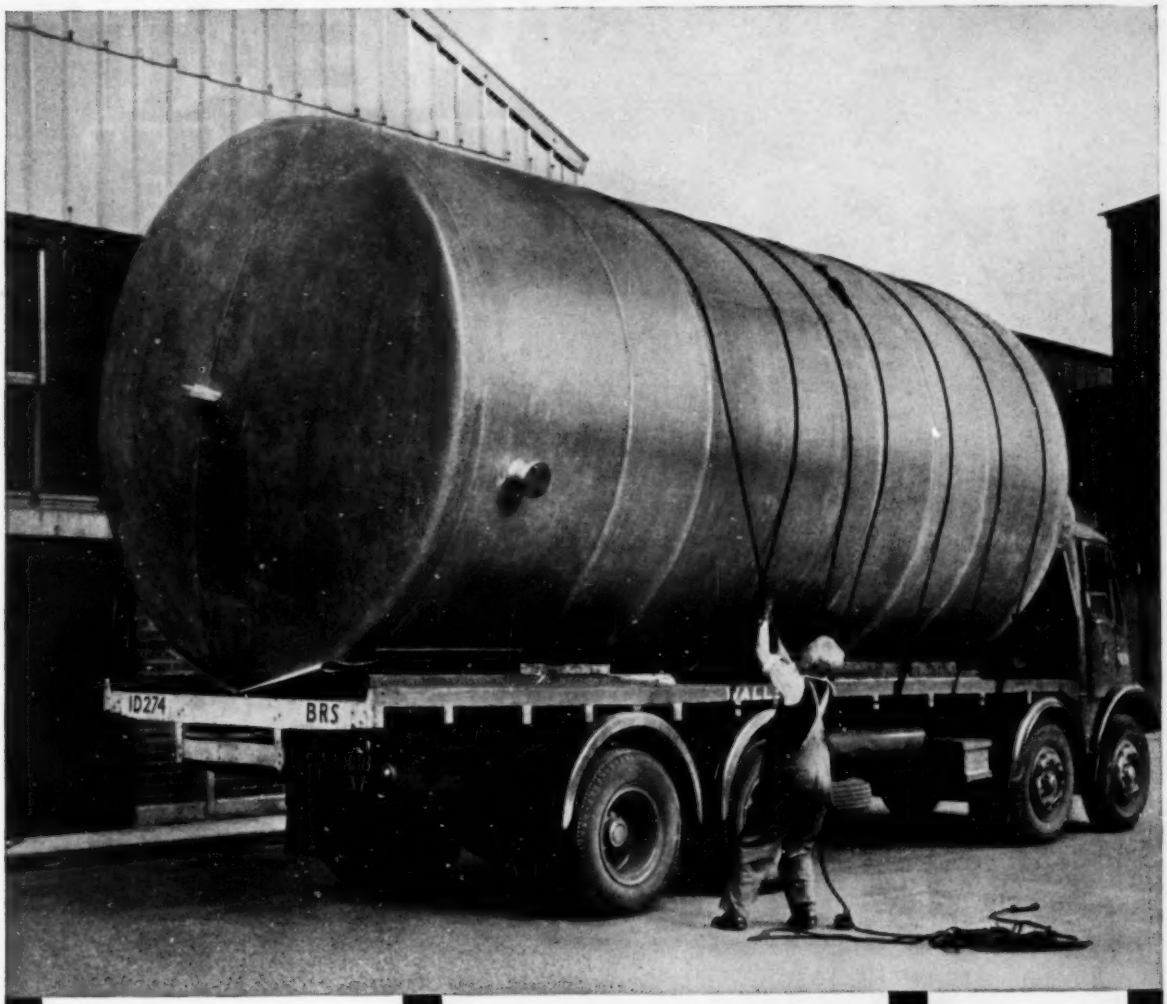

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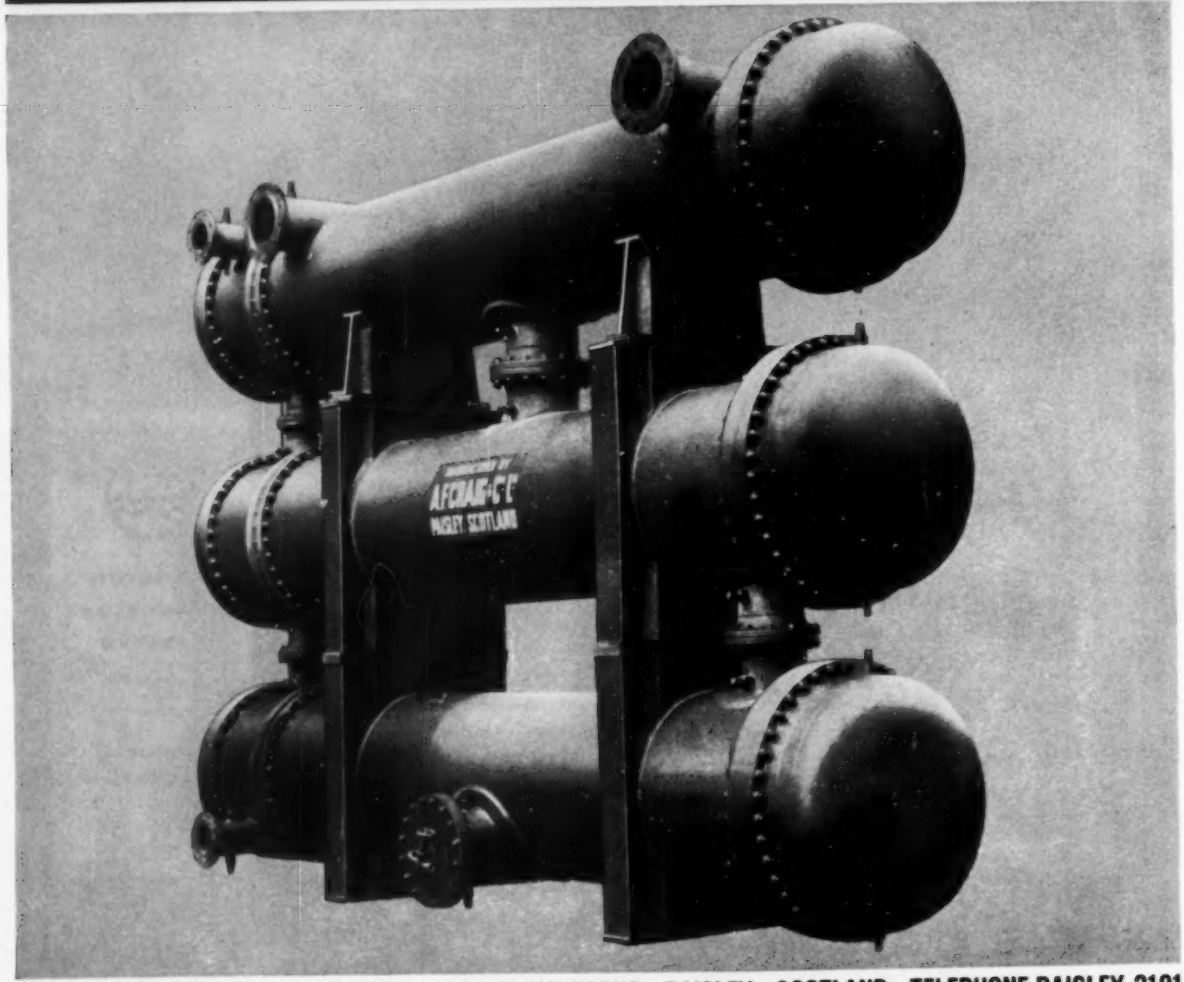

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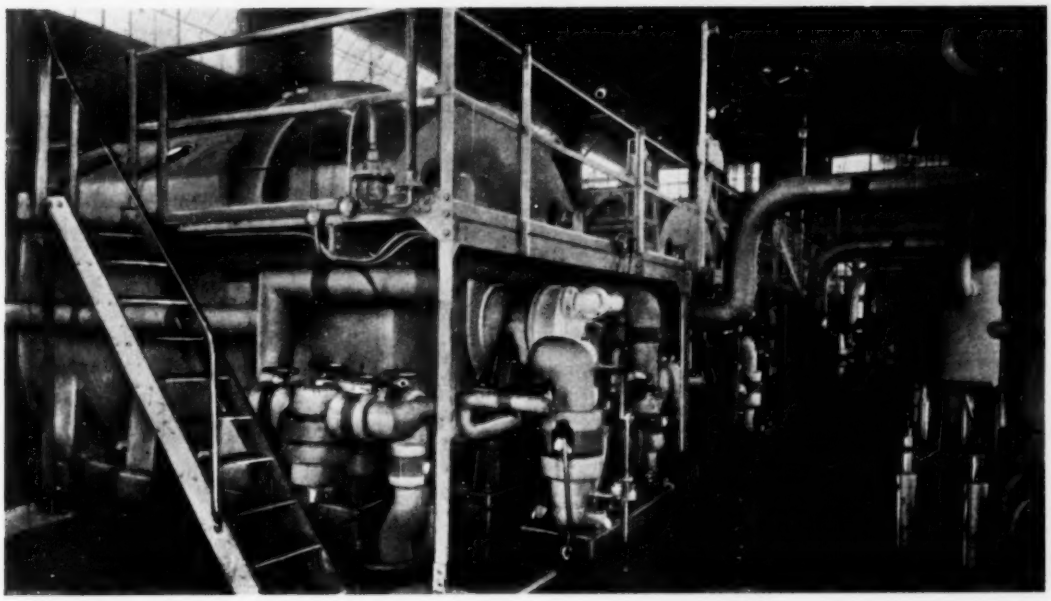

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OILFIELD EXPLORATION AND EXPLOITATION

GEOLOGY

1. Photogeology speeds up groundwork for oil hunters. A. E. Pressman. *Oil Gas J.*, 12.9.60, **58** (37), 162.—Photogeological methods are reviewed, and several examples of interpretation are given with accompanying aerial photographs. A photo-tectonic map of part of the Big Horn Basin in Wyoming shows a vivid picture of different rock types, dips, and strikes, with structural axes, fault traces, and formation contacts. In an area of low relief covered by superficial deposits, the drainage can be helpful, and an example of a radial, sub-annular drainage pattern suggests a dome or positive zone. A photogrammetrically compiled structure contour map in the Kaiparowitz region of Utah is presented, based on spot elevations accurate to 6 ft. Isopach, fracture, and other types of geological map can be compiled from photogrammetric data. C. A. F.

2. Trends in exploratory methods based on statistics from study of basis of location of new-field wildcat wells. B. W. Blanpied. *Bull. Amer. Ass. Petrol. Geol.*, 1960, **44**, 867–99.—Presented herewith for the first time, for the states of Texas, Louisiana, and New Mexico, is much information gathered from files of the statistical data presented by members of the Cttee on Statistics of Exploratory Drilling. 14 tables are given, together with six figures for the 12-years period 1948–59 inclusive, showing statistical percentages in the use of geology, geophysics, and combined geology and geophysics in making new-field wildcat locations.

It was found that more than half of the successful technically located wells were located on a geological basis, and approx 25% on geophysical methods alone. E. N. T.

3. How to choose Eastern Oklahoma datum planes. J. A. Kornfeld. *World Oil*, July 1960, **151** (1), 124.—Because much oil is stratigraphically trapped in E Oklahoma, the correct selection of datum planes for effective subsurface mapping is essential. Difficulties have arisen in the correlation of the Lower Pennsylvanian because of rapid facies changes, but there are some reliable markers, such as the Oswego limestone, which is persistent and occurs above most of the main fields in E Oklahoma. Six key datum planes commonly used in the area are noted and their utility discussed; they are the

Lenapah limestone, Oswego limestone, "Pink" limestone, Inola limestone, and Brown limestone. Electric log cross-sections showing these markers are included. C. A. F.

4. Southeast Oklahoma reawakens as potential gas giant. C. B. Branan and L. Jordan. *Oil Gas J.*, 8.8.60, **58** (32), 120.—Significant gas finds are reported from the Arkoma Basin and Ouachita Mountain provinces in SE Oklahoma, where prospects were previously thought to be of minor interest. The first find was on the Brazil anticline in the McAlester sector of the basin and the second was S of the Choctaw fault in the Potato Hills area of the mountains. The fault forms the boundary between the two structural provinces; to the N there is a series of E and NE trending gentle synclines and more strongly folded anticlines, and to the S of the fault there is complex folding and thrust faulting. Recent developments in the area are outlined, and features of the regional geology are noted. C. A. F.

5. Lisbon is bustling at both ends. F. J. Gardner. *Oil Gas J.*, 19.9.60, **58** (38), 151.—There have recently been active developments along the Colorado and Utah border, where the Lisbon anticline in San Juan County, Utah, has been productive at many places. The anticline crosses the state line, and pays have been found in Mississipian and Pennsylvanian. The Mississippian has gas and condensate at *ca* 8500 ft, and the Pennsylvanian flows oil from *ca* 6000 ft. There are hopes for deeper production in the Devonian, which is being tested. The area had not been drilled until 1959, but six producers have now been completed. Several companies are drilling the structure. C. A. F.

6. Pennsylvanian palæotectonics of Colorado Plateau. R. W. Fetzner. *Bull. Amer. Ass. Petrol. Geol.*, 1960, **44**, 1371–413.—The Pennsylvanian tectonic history of this area as presently embraced by the physiographic province of the Colorado Plateau is summarized in this investigation. The investigation has emphasized unravelling of palæotectonic history by studying its influence on the Pennsylvanian lithofacies. Only stratigraphic problems considered pertinent in deciphering Pennsylvanian palæotectonic relationships or in defining operational intervals are mentioned, and have been constructed from stratigraphic and lithologic data acquired from 264 control points. This was accomplished through the use of isopach maps, lithologic ratio maps, vertical sandstone distribution maps, field evidence, and palæontological data. E. N. T.

7. New Trenton extensions boost Michigan production. R. E. Ives. *Oil Gas J.*, 8.8.60, **58** (32), 122.—There has been a significant increase in drilling in Michigan during the past year, largely due to the discovery and development of fracture type fields in Ordovician Trenton Black River along a trend in the S–Central part of the state. Wells are good producers, but lost circulation and blowouts are problems. At the beginning of May 1960 178 wells were producing *ca* 19,730 bd along the trend which includes the Albion, Pulaski, and Scipio fields. These fields are on the S flank of the Michigan Basin, with beds showing a regional dip N and NE at *ca* 50 ft/mile. The fields occur along a shallow depression in the regional dip, plunging NW. Differential fracturing and dolomitization have occurred along the depression, and production is variable, depending on degree of fracturing and solution. Pays are vugular zones lined with crystalline dolomite and tightly interconnected with fractures. Average porosity is *ca* 5% and average permeability, 3–4 mD. C. A. F.

8. Iowa may have an oilfield. Anon. *Oil Gas J.*, 26.9.60, **58** (39), 267.—Oil has not yet been found in commercial quantities in Iowa, but there are reports that a wildcat in Howard County pumped 45 brl in 15 hr. Two productive zones are claimed: one in the Devonian at 420 ft and the other in the Ordovician at 872 ft. Oil gravity is estimated at 38°. Additional cable tool wells are planned for the area. C. A. F.

9. In Kansas' Hugoton the operator with gas-held acreage holds the whip hand. F. O. Bennett. *Oil Gas J.*, 29.8.60, **58** (35), 124.—During the past ten years W Kansas has become a major oil province with high discovery ratios, high reserves, excellent allowables, and multi-pays. Further outlook for the area is excellent. There are four areas of geological interest: (1) NW Kansas; (2) Hugoton gas field area; (3) SW Kansas; and (4) E area between Hugoton and the Barton arch. 11 formations have found oil and gas production. Structurally the area forms the Hugoton embayment and contains the Hugoton gas field, the largest dry gas field in the world, with 4000 sq miles of productive area. Within this area of shallow gas production there have been recent deep oil finds in the Mississippian below the Permian gas pays. One of these is the Pleasant Prairie field in Haskell County, which is an elongated NW–SE anticline, 7 miles by 2½ miles wide, with at least 95 ft of closure. Regional aspects of the geology of the area are noted. C. A. F.

10. Salt anticlines draw new interest in Paradox Basin. F. J. Gardner. *Oil Gas J.*, 5.9.60, **58** (36), 215.—Production has been developed along the Lisbon anticline which crosses the Utah–Colorado border. Gas and condensate production comes from the Mississippian and Devonian at *ca* 9000 ft. The structure is elongated NW–SE and is salt cored. The structure is apparently non-piercement. In the vicinity there is another large structure, the Gypsum Valley anticline, which is complex with salt piercement. Wells are now being drilled to the Cambrian on this structure. C. A. F.

11. Ouachita Mountains do have oil and gas potential. P. A. Chenoweth. *World Oil*, 1.8.60, **151** (2), 94.—In the past, experimental estimates of the degree of metamorphism have downgraded the Ouachita Mountain area as a petroleum province and it has been claimed that prospects are poor because of: (1) high carbon ratios; (2) metamorphism; (3) sandstones lacking porosity; (4) no adequate source rocks; (5) silicification; and (6) extensive thrust faulting. The evidence for each of these conditions is re-examined, and pessimistic conclusions are refuted. Oil is now being produced from a few small fields within the mountains, such as those along the floor of the McGee Valley. There is stratigraphic trapping, and gas shows are also known. Nine refs. C. A. F.

12. Green River becomes greener oil pasture. J. C. McCaslin. *Oil Gas J.*, 22.8.60, **58** (34), 127.—A recent discovery in the N part of the Green River Basin, Wyoming, has stimulated interest in the oil possibilities of the area, which is little known geologically. It is a complex area involving overthrusting, characterized by several low angle thrusts trending generally N–S. Stresses in the overriding thrust sheets have led to many elongated sharply folded anticlines, locally overturned. Many complex folds have not been drilled. The discovery well, at Mickelson Creek, flowed 360 bd from the Cretaceous Mesaverde at *ca* 3500 ft. C. A. F.

13. Cardium finds its way to gates of Calgary. J. C. McCaslin. *Oil Gas J.*, 15.8.60, **58** (33), 195.—Cardium production has been found along a 30-mile trend NW from Calgary, Alberta, and this may prove to be a major oilfield. Details of recent discoveries are given. C. A. F.

14. Geology of Cobán–Puralhá area, Alta Verapaz, Guatemala. J. L. Walper. *Bull. Amer. Ass. Petrol. Geol.*, 1960, **44**, 1273–315.—Guatemala affords a sample of all types of Central American geology. It comprises a part of old nuclear Central America and its younger borderlands, as well as a part of the still younger volcanic chain that extends from S Mexico to Panama.

The outcropping rocks are of Palæozoic and Mesozoic age. The Tactic and Chochal formations, consisting lithically of shale and limestone, respectively, are of Permian age and comprise the oldest stratigraphic sequence.

Problems of nomenclature were dealt with by proposing the new name Tactic for lower Permian shales which have been erroneously called Santa Rosa, discarding the name Santa Rosa in favour of Todos Santos for the continental beds, and the redefinition of the Ixcoy and Cobán formations.

The area is cut by a zone of major E–W faulting which appears to align with the N boundary fault of the Cayman Trench (Bartlett Trough) in the Caribbean Sea. The thick sequence of limestone, which has been extensively fractured where folded, together with the heavy rainfall, has given rise to an exceptionally well developed karst topography.

E. N. T.

15. Basin-study approach to oil evaluation of Paraná miogeosyncline, S Brazil. R. M. Sanford and F. W. Lange. *Bull. Amer. Ass. Petrol. Geol.*, 1960, **44**, 1316–70.—The main purpose in undertaking this basin study was to arrive at a " favourable area " map for S Brazil which would guide the investigations and exploration drillings of Petrobras.

The Paraná Basin is an ovate basin extending NE–SW through the S part of Brazil and occupying *ca* 1,200,000 sq km. Of this area *ca* 800,000 sq km are covered by outcropping basaltic lava flows, which at once renders most of the normal exploration tools of oil geology impractical and ineffective.

As a result of the study, 180,000 sq km were marked as favourable for oil exploration; *i.e.* as more likely to yield production first, easiest, and quickest, if commercial production is to be found. Though the report traces geologic history and sedimentation from pre-Cambrian to Quaternary, it must be emphasized that the Paraná Basin is essentially an upper Palæozoic basin so far as oil prospects are concerned. All sediments below Devonian may be considered as folded basement, with the possible exception of Silurian. The depositional sequence of sedimentary clastics relevant to oil generation terminated in Jurassic time with the onset of the basaltic flows.

E. N. T.

16. New field is indicated for Chile on Tierra del Fuego. Anon. *World Oil*, July 1960, **151** (1), 84.—A new field has been found *ca* 30 miles S of Gaviota field at Rio Chico in Tierra del Fuego. Oil saturation has been found at *ca* 9900 ft in Springer Hill sand. Other developments in S Chile include the completion of Molino 1 as an oil well near the Delgado field. A large closure below the Magellan Strait encompassing Delgado field and Faro Este field is indicated. Six inclined wells have been drilled from the shore into the Strait. Geological exploration is being started in Aysen, S of the Golfo de Penas.

C. A. F.

17. Turkish strikes spur interest. Anon. *Oil Gas J.*, 26.9.60, **58** (39), 121.—A wildcat 30 miles NE of Diyarbakir, SE Turkey, flowed 22 brl of 38° gravity crude on a 108-min test from 6233 ft and will be deepened to 9842 ft. In a well at Kuleli, in NW European Turkey, oil and gas shows were encountered in the Tertiary at 8850 ft. Another at Bulgarday, 40 miles inland from Mersin, S Central Turkey, tested 1200 bd from 4700 ft after treatment.

J. C. M. T.

18. Review of the main results obtained in Libya. (In French.) A. Parrodon. *Bull. Ass. franç. Tech. Pétrole*, July 1960, (142), 617–30.—Oil search permits have been granted on more than 10^6 km² of Libya, the total area of which is $1{\cdot}77 \times 10^6$ km. There are three great provinces: in the W involving Palæozoic and Triassic, closely linked with the Algerian Saharan basins; in the NE Cretaceous and Tertiary basins; in the SE the Palæozoic basin of Koufra. The W province has a thick series of Cambro-Ordovician quartzitic sandstones. Most of the Gothlandian is black graptolitic shale; the Devonian was a period of instability, and members may rest on Gothlandian or Cambro-Ordovician. Movements led to the Carboniferous being most complete in the S. A clay–dolomite–gypsum series marks the end of the Carboniferous or Permian. The Trias started with detrital rocks and ended with evaporites. Mainly continental deposits occur in the Jurassic and Lower Cretaceous, but the Upper Cretaceous is marine. There is an extensive monocline with feeble deformations and minor faults, so that stratigraphic factors often dominate oil accumulations. The chief production is from Upper Gothlandian, Devonian, and Tournaisian sandstones, as well as the Lower Trias. The first find was at Atshan (Devonian). 60 km S, El Haghe produces from the Ordovician at 700 m. The Trias has given important amounts of dry gas at Ouled Chebbi, where it lies on Ordovician.

The E province had a large trough in the Jurassic and Lower Cretaceous, a platform to the S being submerged in the Upper Cretaceous. Carbonates and evaporites were deposited until the Oligocene. A recession at the end of the Oligocene was followed by a transgression to the SE in the Miocene. A series of folds parallel to the coast are dropped by faults in going N. Folding diminishes in intensity S. So far no signs of oil have been obtained in the coastal zone of Cyrenaica, and interest is concentrated on the Syrte Basin, where the main reservoirs are Upper Cretaceous–Eocene dolomitic limestones with reef facies. The first discovery was in the Cretaceous at 2000 m at Bahi. 50 km SE, Dahra produces from the Cretaceous and Paleocene at rates of 115–1300 m³/day/well. Sub-reefal Paleocene limestones have given wells capable of 2800 m³/day at Zelten. Oil has been found in presumed Palæozoic beds and indications in fractured granite below Cretaceous. Palæocene limestones have given oil at Mabruck and Zahaligh.

Of 70 exploratory wells drilled in Libya, 18 have produced oil and three gas; in the Algerian Sahara 163 exploratory wells gave 14 oil producers and 33 gas producers.

G. D. H.

19. Coulommes–Vaucourtois field and the Dammartinen–Goele perimeter. (In French.) R. Tilloy and M. Dardanne. *Rev. Inst. franç. Pétrole*, 1960, **15**, 994–1003.—Water well data for the Albian showed the periclinals of Bray and Beynes–Meudon. Seismic work and core drilling to the Jurassic were undertaken. The Tertiary and Chalk especially showed very rapid velocity variations. A high was found SW of Meaux and checked by wells. 94 50–150-m holes to the Lutetian gave a general structural picture for most of the perimeter. In addition to the Bray and Beynes axes, the Multien anticline was indicated.

Coulommes 1 was drilled into the Jurassic and found shows in the Lusitanian, but these gave only water on test; the Dogger produced oil. 33 wells have been drilled. Up to 33 m of impregnation has been observed in the SW, and 50 m on the NE high. The accumulation is *ca* 5 km long and 3 km wide. There may be a fault on the NW. The R1 reservoir is oölitic; beneath is fractured sub-lithographic limestone with oil in fissures. The R3 reservoir is a detrital limestone with good porosity and permeability in parts. The rocks suggest a sub-reefal facies. Oil is produced by water-drive. Some wells flow; others must be pumped. In March 1960 the output was 600–700 m³/day.

Discordances occur at the top of the Lias and in the Bajocian, as well as at other horizons.

Impregnated Bathonian has been found on the Saint–Mard–Nantouillet structure; there is oil in Sinemurian marls on the Multien anticline; impregnated Bathonian was found in Montlevee 1, 3 km NE of Coulommes; Belon 1 had impregnated Dogger, with the same water level as at Coulommes, and traces of oil in the Aalenian.

G. D. H.

20. History of the search for oil in the Paris Basin. (In French, English, and Spanish.) Anon. *Rev. Inst. franç. Pétrole*, 1960, **15**, 988–93.—The early work was in 1923–27,

when a well on the Bray anticline failed to find oil. In 1951 the Institut Français du Pétrole undertook studies; the entire area was covered by a gravity survey. Local seismic work was carried out, and some core holes were drilled. The thickness of sediments was greater than expected. Deep exploration began in 1953, and in 1954 Courgivaux 1 had oil shows from the upper part of the Middle Jurassic to the Rhaetic sandstones. Non-commercial production was obtained in Pays-de-Bray 101 in the Dogger. The Middle Trias showed oil at Forcelles. In 1958 Coulommes 2 began to produce from the Upper Dogger. Other finds were made in Chateaurenard 1 (Dogger and Neocomian), Chailly-en-Biere 1 (Dogger), St Martin-de-Bossenay (Dogger), Villemer 101 (Dogger, with a Sequanian show), and Granville (show in Rhaetic).

G. D. H.

21. Saint-Martin-de-Bossenay field. (In French.) P. Bouche *et al. Rev. Inst. franç. Pétrole*, June 1960, **15**, 1028–45.—The Aube and Yonne concession has Jurassic to Tertiary beds at the surface. The beds strike WSW–ENE and the basinward dip is interrupted only by rare faults and terraces. A 1/20,000 geological map was prepared, and seismic reflection surveys were carried out. Lateral variation, surface conditions, and drilling problems raised difficulties. A marker near the top of the Lias indicated noses, and a 5-km long N–S anticline near Saint-Martin-de-Bossenay. SMB1 was drilled to 2396·8 m in 1959, showing oil in the Dogger limestones. The Cretaceous consisted of limestones, marls, and some sands. The Malm showed limestones and marls, and the Lias was mainly clay, extending from 1765 to 2370 m. Variegated clays, gypsum, and anhydrite were found in the Trias. The Lower Callovian and Bathonian had oil impregnation, and the base of the Dogger and top of the Lias had fluorescence. The Upper Dogger flowed 70 m³/day. Ten wells have been drilled. The upper reservoir unit (Lower Callovian) is oölitic and bioclastic; the lower unit (Bathonian) is irregularly dolomitic. Permeability ranges between one and several hundred mD. Pore sizes vary widely. Fissures occur. Interstitial water is 25–30% and the bottom water is at *ca* −1530 m.

No measurable amounts of gas are produced with the oil. The pressure was 144 kg/cm² at −1275 m, and has not dropped in producing 30,000 m³ of oil. An active water drive is indicated. Two wells have been completed open-hole, and the rest have been perforated, after squeezing cement *ca* 15 m above the water zone. Paraffin wax is removed from the tubing mechanically. Epikote-coated tubing at the top of the well has prevented wax deposition. The oil is 33·4° API and has 0·21% of sulphur.

Microphotographs of the reservoir rock are appended, and there is a structural map and composite log. G. D. H.

22. Chateaurenard field. (In French.) V. Mauguy. *Rev. Inst. franç. Pétrole*, 1960, **15**, 1004–10.—By the end of 1958 seismic reflection work had indicated *ca* ten structures on a 20,000-km² concession, some having been drilled, and the Chateaurenard anticline had been found, 20 km E of Montargis. It runs NW–SE for 3·5 km, is 2 km wide, with 15 m closure at the top of the Kimmeridgian. Chateaurenard 1 was drilled to 1975·8 m in 1958, reaching the Trias at 1967·5 m. Oil shows were noted, especially in Neocomian sands at 562·5–568 m, and this horizon began to produce 5·75 m³/day in Aug 1958. The sands pass rapidly to clays, or can be cemented tight unpredictably. Only four of 11 wells drilled produce, three from two horizons. A sand watered in the well produces at lower levels in other wells, the first well being on a separate high against the E marginal fault. Core recovery has been poor. Well tests suggest permeabilities of 1500 mD. There is 30–35% interstitial water. The wells give *ca* 25% water. The cumulative oil output was 18,681 m³ at the end of 1959. There is no dissolved gas; there is a very active water drive. The crude is 0·893 gm/cc, and 0·926 gm/cc in the upper sand of Chateauranard 1. All wells are pumped. Wax deposits and sand rarely cause stoppages.

Shows have been noted in the basal sand of the Neocomian, and in the top of the Portlandian. Chateaurenard 1 had irregular impregnation in the upper part of the Bathonian. The Sequanian gave a little oil from a fissured, sub-lithographic limestone in Sens 1. G. D. H.

23. Villemer field. (In French.) Regie Autonome des Pétroles. *Rev. Inst. franç. Pétrole*, 1960, **15**, 1046–50.—The Villemer structure is E of Nemours on the S flank of the basin, and seems to be an extension of the Beaumont–Aufferville–Puiselet axis. The Aufferville well gave shows of oil in 1959. Several gentle undulations are indicated by seismic work. An 8-m fault has been shown in Vm 101. Cretaceous occurs at the surface, and some oil is found in the Lusitanian. The underlying Callovian at *ca* 1460 m is marly, the Dogger beneath being calcareous, with porosities of 13–14·8% and permeabilities of 70–140 mD, making it a better reservoir than the Lusitanian. The Lusitanian oil has 0·54% sulphur.

Vm 101 had a static pressure of 163·6 kg/cm² at −1500 m. Productivity indices of 0·25–1·8 m³/day/kg/cm² have been calculated. The three wells have been acidized. In April 1960 the field production was 90 m³/day. G. D. H.

24. Chailly–Chartrelles field. (In French.) Anon. *Rev. Inst. franç. Pétrole*, 1960, **15**, 1011–19.—Chailly–Chartrelles is a high on an ENE uplift. Oil was found by Chailly 1 in 1958. Surface geology is a little guide to subsurface structure, and seismic reflection work encountered difficulties due to velocity variations in the Tertiary and Cretaceous, and to surface conditions. Wells showed considerable variations in the Dogger. 33 wells have been drilled. Two domes separated by an ENE–WSW fault with a 10-m throw to the N are shown. 130 m of Tertiary covers 850 m of Cretaceous. Detailed lithological studies have been made on the Callovian and Dogger. Five horizons show good reservoir characteristics, all being limestones. Two discordances occur.

A map, cross-section, and electric logs are appended.

G. D. H.

25. Geological results of some petroleum drillings in the westerly molasse basin. (In German.) E. Volz. *Erdöl u. Kohle*, 1959, **12**, 209–16.—The most important geological results of investigations from 1949 to 1955 in the petroleum concessions Saulgau and Markdor (Baden-Wurttemberg) are reported. An overall picture of the drillings is presented, also of facies profiles of the lower fresh water molasse, of investigation drillings, and a contour plan of the boundary molasse/Malm. Oil occurs at the head of the Malm at Ettenkirch, but fails in the molasse. From 2045 to 2140 m a light, aromatic-smelling oil, vaporizing rapidly under degassing, was produced from fissures and calc-spar druses. In wells Fronhofen 1 and 2 oil was established S of an antithetic disturbance, and limited to the upper 5 m of the Malm. This oil is associated with the finest tectonic hair cracks and calcite druses. At Fronhofen 2 the deeper basin drillings in the Malm are not oil-impregnated, but impregnated cores come from fresh water limes and sands of the lower fresh water molasse at 1165 m, 38 m above the lower limit. The best oil indications appeared on the Saulgau drillings on the S fault block of an antithetic disturbance. Gas appeared at 205 m above the base Tertiary, oil from 443 m to the final depth, a max in the fresh water limes; the oil is residual. In all borings excepting Fronhofen 2 the Chatt was oil-producing. Molasse oil was found over all in the Chatt. Only in the contact region Chatt/Aquitaine gas traces occur. Comparison is made with the Swiss molasse. The origin of the oil is discussed. 13 refs. R. T.

26. Mighty Alborz structure is finally tamed. Anon. *Oil Gas J.*, 8.8.60, **58** (32), 64–5.—Alborz-8 is being completed as a 20,000-bd well from an interval tested at *ca* 10,500 ft. Total depth is 11,525 ft; the lower sections tested salt water. The well is 1¼ miles SE of Alborz-5, which blew out four years ago, and encountered similar drilling difficulties with salt, anhydrite, and plastic red saline marls. J. C. M. T.

27. Palæogeographical study of the U.S.S.R. petroliferous regions. S. G. Sarkisyan. *Rev. Inst. franç. Pétrole*, 1960, **15**, 811–35.—In Azerbaidjan production is from the Ackhagyl–Pontian clay, silt, sand, conglomerate series. Mineralogical studies have indicated several provinces, and the sources of the minerals have been determined. Attention has been paid to varieties of quartz. Evidence of lagunar conditions has been noted, and it is suggested that source rocks occur within the productive series.

E Georgia produces from the Shirak and Kakhetie. The lower beds are clay–sand deposits, and the upper beds sand–conglomerate deposits. The Shirak is of lacustrine and fluvial origin; its oil is believed to be from the underlying marine Sarmatian.

In the N Caucasus signs of oil are found in a thick series of Tertiary and Mesozoic rocks, but production is mainly from the former. Conditions favourable for source rock formation are believed to have occurred in the Khadum, Maikop, and Chokrak beds. Mineralogical studies have afforded information on the changing palæogeography.

The Turkmenia deposits were formed in a closed shallow basin. In the Emba region mineralogical work has been on the Permo-Trias, Jurassic, and Cretaceous. Oil occurs in the Palæogene and Upper Cretaceous of the Ferghana Basin, these beds showing continental and marine or lagunar environments. Special attention has been given to the carbonates, sulphates, and salt series, and it is suggested that the dolomites are formed in the presence of ammonium carbonate which arises from organic matter.

Oil and gas occur in the Devonian, Carboniferous, and Permian of the Ural–Volga region. The Devonian is most important. Rapid variations in the facies and the absence of fossils in the Permo-Trias have meant that only petrographic and mineralogical techniques are available for correlation. The mottled beds were deposited in small closed basins which were in communication at some times. The chemical conditions in the basins have been indicated, as well as processes of diagenesis. In some cases mottled deposits formed in fresh water lakes; in others under lagoonal, marine, and deltaic conditions.

Palæogeographical studies have made it possible to indicate stages in the deposits which may be favourable for source or reservoir rocks. Lithofacies maps have been developed in some areas. Light as well as heavy minerals may give useful criteria. Authigenic minerals help in some cases, as can clay minerals. Pyrite and siderite point to reducing conditions.

There are imperfections in the methods of study, identification, and presentation of data on the sediments and their contents. G. D. H.

GEOPHYSICS AND GEOCHEMICAL PROSPECTING

28. Geophysical data for trade and sale. P. B. Bike. *Oil Gas J.*, 26.9.60, **58** (39), 269.—A geophysical exchange service is developing in the U.S.A. and Canada which should increase the efficiency of geophysical exploration. Terms and conditions of geophysical library services vary from area to area, but price schedules are substantially lower than the cost of new shooting. Leads developed by re-analysis of trade records have provided in some cases further work for geophysical contractors. The main centres are at Calgary, Caspar, Dallas, Denver, Fort Worth, and New Orleans. Data trading should enhance geophysical activity, leading to improvements in techniques for improved record quality. C. A. F.

29. Geophysical activity. Anon. *World Oil*, 15.8.60, **151** (3), 98.—World geophysical activity declined during 1959, the number of party months being 11,481, or 8·8% less than in 1958. Increases in seismic work were, however, reported from the U.S.A., Argentina, Africa, and the Far East. Apparent trends in geophysics include increased efficiency due to improved equipment, instrumentation, and interpretation, and some marginal fields of activity are being replaced by the detailed study of specific prospects. There is less use of reconnaissance methods. Details are given of geophysical crew-months in the Free World in 1959, by countries and areas. C. A. F.

30. Here's how oil hunters use the stomper as a seismic tool. C. L. Kimbell. *Oil Gas J.*, 19.9.60, **58** (38), 154.—Although the weight-dropping technique in seismic prospecting was first tested in 1924, it was not commercially adopted until 1953. Seismic waves are generated by a falling weight, and magnetic recording with integration has been introduced. Details of the present operation of the system, known as the stomper, are given. The drop is 8–9 ft at a rate of 1 in 12 sec, and the energy is equivalent to 4–8 lb of dynamite. The weight measures 6000–11,000 lb and is carried on a self-propelled vehicle. A magnetic field recorder is equipped to record the seismic signals sequentially and drops are placed in patterns. Reflected energy is stored on tape in the field and stations are usually placed 2000 ft apart. Experience in Mississippi has shown that a composite of 12–24 weight drops is enough to give good record quality in many areas. C. A. F.

DRILLING

31. Split travelling block speeds up tubing jobs by 50%. E. McGhee. *Oil Gas J.*, 12.9.60, **58** (37), 100–3.—By using a so-called split travelling block it is possible with a pole-mast servicing rig to run four tubing singles/min and to pull three/min. The split block has two separate sheaves between which the tubing is able to pass. Thus the block and elevator assembly need never be swung to one side to clear the tubing, but instead slide up and down it. A separate transfer elevator and hoist is used to move tubing to and from the rack and support the upper end, leaving the main elevators free to carry out only the pulling and lowering. Movement of the elevators in pulling and running operations is almost continuous, and the operation is less hazardous for the crew and kinder to the engines. It is believed that a similar system could be used on large drilling rigs. J. C. M. T.

32. More from drilling-rig engines. E. McGhee and C. Hoot. *Oil Gas J.*, 26.9.60, **58** (39), 123–44.—The factors governing the choice of drilling-rig engines and their fuel and maintenance are reviewed from the point of view of economy. De-rating of engines to 65% of their intermittent hp is advisable; charts are provided to show de-rating necessary to allow for high altitude and high air temp. Natural gas is the best fuel when obtainable, maintenance as well as running costs being lower than with diesel engines. Ignition timing of gas engines must be changed if they are run on LPG, and even more so for butane–propane mix. Idling for 5 min after starting and for 10 min before shutting down prevent excessive wear and distortion. Daily, weekly, and monthly inspection and maintenance schedules should be carried out. The cooling system deserves special attention; the best water available should be used, treated with softener and rust preventer, and losses should be minimized. J. C. M. T.

33. Mid-Continent hot spot owes success to modern well-stimulation techniques. M. C. Respess. *Oil Gas J.*, 12.9.60, **58** (37), 93–6.—In Kingfisher County, Oklahoma, in 1960, 12 out of 15 wildcats were successful and 48 out of 49 field wells successful, but only because of modern methods of stimulation on the principal Pennsylvanian and Mississippian reservoir rocks. The Oswego lime requires a retarded acid type fracture treatment. The Manning sand and the Meramec limestone call for either oil fracture or retarded acid fracture treatment. After such treatment, the wells can be expected to flow from 58 to over 1000 bd for some months. Details of the treatments are given. J. C. M. T.

34. Effect of some drilling variables on the instantaneous rate of penetration. H. D. Outmans. *J. Petrol. Tech.*, June 1960, **12** (6), AIMME Tech. Paper No. 8117, 137–49.—The drilling mechanism has been analysed in order to assess the effects of different factors. The volume of fractured rock around a vertically-penetrating bit tooth is given as a function of tooth pressure and angle and drilling fluid pressure (the rock is assumed to have low permeability), with the assumption of fracturing preceded by plastic flow. A comparable expression is obtained for tooth penetration in cuttings resting on the bottom. Together these relate depth of tooth penetration in virgin rock, the amount of cuttings retained, and other variables. Relating cutting vol and drilling rate, hydraulic bit hp, and mud pressure yields formulæ for drilling rate for viscous or turbulent flow, and instantaneous or delayed cutting removal. The drilling rate is not directly proportional to the product of bit wt and some power of rotary speed. For high values of the hydraulic hp at the bit nozzles the drilling rate is nearly directly proportional to the rotary speed and proportional to the square of the bit wt. Drilling rate increases with rotary speed, but at diminishing rates.

Comparison with field and lab data indicates that the assumed model approximates to the actual drilling mechanism. G. D. H.

35. Drilling analysis charts. O. E. Mechem. *Oil Gas J.*, 22.8.60, **58** (34), 66–72.—Good programming is the key to lower drilling costs, and is encouraged by the use of drilling analysis charts. A recommended style of (copyright) chart employs a vertical scale of 1 inch to 1000 ft and a horizontal scale of 1 inch to 10 days. Three depth/time curves are plotted; one of cumulative rotating-on-bottom time, one of "net drilling time," *i.e.* rotating-on-bottom plus trip plus bit-changing plus rig servicing plus normal mud mixing time; and a curve of overall drilling time. In columns alongside the curves are graphic records of casing and hole programmes, specification vol and pressures of drilling fluids used, drilling wt, rotary speed, details of bits, hole-drift, an electric log, and formation marker tops. A further section is devoted to details of the rig, drilling and completion operations, etc. Used in conjunction with a well cost statement, such a chart assists identification of practices which call for improvement and aids the design of the optimum programme for future wells. Forecast accuracy for costs of better than 95% is claimed. J. C. M. T.

36. Greater accuracy from free point indicators. J. N. Donhaiser. *Oil Gas J.*, 29.8.60, **58** (35), 93–6.—Present-day practice of deep wells and long drill-collar strings calls for max revolving power in free point indicators, used to locate level of stuck pipe. There are two widely used types of instrument. One embodies a strain gauge which measures the deformations due either to stretch or torque in the pipe. The other measures changes in the inductance of a magnetic circuit caused by strain in the pipe. Both are run inside the pipe and indicate at the surface. Problems which arise are discussed and an improved instrument only 1¾-inch dia is described. J. C. M. T.

37. Four new drilling tools bow in with completion of Jersey research lab. Anon. *Oil Gas J.*, 5.9.60, **58** (36), 100–2.—Four devices recently developed to aid drilling are described. A wall-anchored drill collar has been designed for use at shallow depths which limit the length of drill collars. A force of up to 40,000 lb can be exerted on the bit although the tool weighs only 2200 lb. Mud pressure is used to anchor the outer part of the tool to the wall and to exert the downward force.

A bottom-hole drilling recorder 6¾ inches dia by 15 ft long employs tape to record wt and torque on the bit, vertical, angular, and lateral accelerations, pressure inside and outside the drill pipe, and temp.

Low energy γ rays are used in a tool for determining the site and nature of fluids entering wells and, in conjunction with an inflatable-packer flowmeter, their direction and quantity.

A high pressure chamber is being used to study by high speed photography the effect of percussion on rocks at pressures up to 15,000 psi. J. C. M. T.

38. Kingfisher wells are completed with air. C. M. Cole. *Oil Gas J.*, 12.9.60, **58** (37), 97–9.—Wells in E Hennessey field, Oklahoma, are completed with air to avoid damage to the producing formation (the Meramec) found to occur with mud. After cementing casing above the pay the plug is drilled with water to the casing shoe. The water is then unloaded with air, and drilling continued through a blow-out preventer and rotating drilling head *ca* 90 ft into the Meramec. The hole is then loaded with oil, logged, fractured, and a permanent packer is set above the Meramec before unloading. Initial production appears to be substantially higher than in wells completed by other methods. These wells are also completed in the overlying Manning formation; production from this and the Meramec is via separate parallel tubing strings, the upper zone perforated by means of a gun which incorporates a simple new aligning device. J. C. M. T.

39. Methods and materials used in drilling in the U.S.S.R.; report of visit from 4 to 24 March 1958. J. Raynal and C. Rosoff. *Rev. Inst. franç. Pétrole*, 1960, **15**, 836–905.—The organization of the Institute of Drilling is described, together with studies on the breakdown of rocks and the action of bits. Work is proceeding on the form and distribution of bit teeth. Turbo-drills of 6¾–10-inch dia are in use. Short section turbines have been developed for directional drilling, and there are turbo core cutters. Turbines and bits have been made which can be changed without withdrawing the pipe. Two and three wells have been drilled simultaneously from a single derrick, pipe being transferred from one well to the other as is convenient. Large dia holes are being drilled by slowly rotating mounts of two, three, or four turbo-drills.

Electro-drills have a sectional cable in the drill pipe. Speeds of 530–920 rev/min are used with weights of 15–35 tons on the bits and dia of 6¾–10 inches. An electro-drill costs about four times as much as a turbo-drill. Encouraging results have been obtained with an electro-drill suspended on a cable. A centrifugal pump lifts cuttings off the bottom into a collector above the drill, and it is possible to drill 12 m before pulling the drill to remove the cuttings. Eight-conductor cables are 3 cm dia and weigh 2 tons/km. A round trip can be made in 15 min at 1000 m. The rate of advance is only 2 m/hr because of the small weight on the bit. It is hoped to increase drilling rates by using rates of rotation to 1500–2000 rev/min.

A percussion bit has been modified to have a cutting catcher into which cuttings are carried by the operation of valves motivated by the drilling action. This is expected to triple the percussion drilling rate, but it may not be suitable for drilling below 1600 m. Drilling by explosive charges carried down by the drilling mud can give 8-cm holes in air and 30–

35-cm holes in mud. Drilling by rotary with rapid mechanical vibration and by electrical discharge is being investigated.

Derricks are available which are in effect erected from the top downwards. The main power is diesel or electric motor. Various steps have been taken towards automation of operations arising in round trips, and automation has been introduced into cementing.

Details are given of turbo-drilling and electro-drilling in fields in Western Bashkiria; there is reference also to organization and to the payment system. Some comparisons are made with French equipment and operations. G. D. H.

PRODUCTION

40. Calculation principles for heating oil-bearing rock strata for yield increase. (In German.) F. Trey. *Erdöl u. Kohle*, 1959, **12**, 216–18.—With the derived formulæ the heating of an oil-producing stratum—at const output of the heat source—can be calc without further aid, provided that the heating has attained a prescribed action radius. Applicability of the approximation formulæ is shown by comparing a temp distribution in the heated stratum calc with the derived formulæ with a temp curve evaluated numerically for the present case. R. T.

41. Why sucker rods fail. J. Zaba. *Oil Gas J.*, 12.9.60, **58** (37), 114.—Fatigue failure in sucker rods is dependent on max stress, range of stress, and number of reversals. The Goodman diagram illustrates the principle that minimum stress must increase with max stress to maintain the allowed range of stresses. In deep wells, sucker rod wt represents a large part of the polished rod load, and this condition is easy to attain, but in medium and shallow wells pumping large vol of fluid, especially at high speeds, the down-stroke load may be low compared with the upstroke. For corrosive service, max allowable stress is lowered by arbitrary factors, *e.g.* for one particular grade of steel, by 0·90 for salt water and by 0·64 for hydrogen sulphide service. J. C. M. T.

42. Paraffin deposition. R. J. Cole and F. W. Jessen. *Oil Gas J.*, 19.9.60, **58** (38), 87.—A lab investigation has been carried out on the effect of temp gradient at the interface between a pipe wall and crude oil and the wettability characteristics of the system on paraffin wax accumulation. Higher initial rates of deposition occur when the temp differential is high, but the rate of accumulation decreases with time as the overall conductivity is reduced by the deposited wax. The wetting characteristics of the surface have a significant influence on the amount of wax deposited. By increasing the contact angle of water on the surface from 9° to 95°, the amount of wax accumulated at a given temp was decreased by 65%. On surfaces having a high free surface energy, the amount of wax deposited is reduced by addition of water, which is preferentially adsorbed. J. C. M. T.

43. Scientists solving reservoir mystery. R. J. Enright. *Oil Gas J.*, 12.9.60, **58** (37), 66–8.—Atlantic Refining Co is studying numerous cores cut from outcrops of typical producing sands in Utah, Colorado, and Wyoming, in a large-scale investigation into reservoir heterogeneity. A hand-guided, air-operated 1-inch diamond coring tool is used, cores being cut 1 ft deep with spacings of down to 6 inches. Permeability, porosity, grain size, and cementation are studied. It is believed that the kind of variation to be expected in any blanket-type marine sand can already be deduced from the results to date, but further studies are required on bar-type sands, channel fillings, deltaic sands, turbidites, and all kinds of limestone. This work is intended to meet the need for more exact knowledge of permeability variations demanded by miscible-drive secondary recovery methods. J. C. M. T.

44. Chromatographic transport of reverse-wetting agents and its effects on oil displacement in porous media. A. S. Michaels and R. S. Timmins. *J. Petrol. Tech.*, June 1960, **12** (6), AIMME Tech. Paper No. 8118, 136A (summary).—Water was displaced from 1 to 4-ft 140–200-mesh silica sand columns by oil in heptane, then after flowing 0·25 void vol of water into the sand 0·026 void vol of aqueous soln was added, the water flow being resumed. Oil and additive concn were measured as a function of throughput for flow rates of 8·3–42 ft/day. Slugs of dilute butyl and hexyl amine soln caused slight reduction in oil recovery; more concentrated soln increased recovery, and showed a clear secondary oil bank moving with the amine band (this occurred only when the additive caused strong preferential oil-wetting of the silica). Increased oil recovery is attributed to transient changes in oil–solid wettability during amine transport, favouring movement and dispersion of isolated oil masses. G. D. H.

45. Result of well stimulation by hydraulic fracturing and high rate oil backflush. W. K. Ghauri. *J. Petrol. Tech.*, June 1960, **12** (6), 19–27.—80% of the treatments were in the Brea–Olinda field associated with a steep monocline S of the Whittier fault, the reservoirs being Upper Miocene lenticular sandstones in shales and silts at depths of 2500–8100 ft. The oil gravity is 24°–31° API. The producing section is 80–1680 ft thick. The treated wells have averaged 80,000 brl each. Permeabilities range 1–500 mD and average 15–40 mD. Solution gas drive aided by gravity drainage controls production. At the time of treatment pressures were 500–2000 psig. Initially hydrofrac was used, and then sandoil frac. In both cases much Ottawa sand had to be bailed from the well after treatment and in production. Then injecting oil without solids was tried. The first two methods were believed to cause some fracturing, probably vertical. In high-rate oil backflush casing type treatment was considered better than casing-tubing annulus with the pump hp available for giving rates of 20–35 brl/min. As with the hydrofrac and sandoil frac there was no discernible breakdown on the pressure record. Sealing of fractures with oil backflush may account for less sustained production than after the other types of treatment; the benefits may arise from flushing the sand face and nearby rock, removing blocking particles and possibly water block.

Response after treatment has ranged from no change in behaviour, though transitory increase in production, to sustained increase in output with a flattened decline.

Sandoil frac gave greater additional recovery than the other methods; backflush was least expensive and possibly best on a recovery/cost basis. Composite decline curves for wells treated in different ways showed that hydrofrac and sandoil frac lowered decline rates; oil backflush gave an increase, and high injection rates seemed to give greater recoveries. The treatments are considered to have given additional (0–550,000 brl) rather than accelerated oil. Early application appears best. G. D. H.

46. History of a Milham sand water flood following accidental stimulation. F. T. Jones. *J. Petrol. Tech.*, June 1960, **12** (6), 33–5.—The Milham (Pennsylvanian) sand is bar-like, lying on the S flank of the Red River uplift in Wilbarger County, Texas. Its average thickness is 15·1 ft, permeability averages 86·7 mD, the connate water was 47·5%, and the residual oil saturation is estimated as 20·4%. Development was almost complete by 1930, and primary production was essentially over when water flood began. Gas re-pressuring was applied for several years, with no marked increase in production. In 1946 two producers were converted to salt water disposal wells to take 72 bd of produced water. Two further wells were converted to take more water, and an offset well in three weeks rose from 1 to 52 bd with 11 bd of water. A modified seven-spot was then applied with success and expansion of the

flood has continued since 1949. Injectivities and productivities have fallen, and fracturing of new and old wells is now standard procedure. Open-type water treatment was adopted in 1955 after completing a water supply well in the Hickory sand, but high costs led to the use of a closed system in 1959.

Before flooding, 4,210,613 brl of oil had been obtained from 12,704 acre-ft; secondary recovery has given 2,768,838 brl from 10,667 acre-ft, the injection being 19,431,108 brl.

G. D. H.

47. Diffusional behaviour and viscosity of liquid mixtures. A. W. Adamson. *J. Petrol. Tech.*, June 1960, **12** (6), AIMME Tech. Paper No. 8119, 86 (summary).—Interchange of position between neighbouring molecules, at essentially constant vol, is taken as the basis for the mathematical study. The rate of position exchange is handled in terms of absolute rate theory, and a relationship for the mutual diffusion coeff is derived. A relationship for the visc of binary mixtures has also been obtained. The equation fits visc data for such mixtures fairly well, including some non-ideal systems. Various empirical and semi-empirical relationships for the visc of binary mixtures can be shown to be simplified forms of a parent general equation based on pair-wise interactions.

G. D. H.

48. Case histories show value of corrosion inhibitor squeeze treatment. R. H. Poetker. *J. Petrol. Tech.*, June 1960, **12** (6), 36–40.—Annulus batch treatment with inhibitor to prevent corrosion in gas-lift wells was not especially effective, and therefore squeeze treatment was adopted. 60 wells in ten different fields and involving 19 reservoirs at depths of 3000–12,000 ft have been treated. Water-soluble, oil-soluble, and oil-soluble water dispersions of inhibitor have been used in various concn. The pumping pressures and rates have been kept below values which might cause fracturing. Generally 15–50 brl of fluid was forced into the formation; the max was 250 brl. Large treatments were on wells producing large vol of water. The iron content of the water produced showed different forms of behaviour: (1) rose and remained high for a few weeks before dropping sharply to a low value; (2) dropped to a low value quickly and remained low; (3) oscillated before going to a low value.

A number of well case histories are described. The technique is cheap, and has succeeded in wells which have not responded to other methods.

G. D. H.

49. Adjustment of PVT results. (In French.) R. Nogues. *Bull. Ass. franç. Tech. Pétrole*, July 1960, (142), 633–42.—Surface and subsurface oil samples from wells for PVT studies are not always true samples of the material initially in the reservoir. Corrections are therefore necessary before they can be used correctly. By means of a Y function, adjustments can be made to flash liberation data if the bubble point in the reservoir is known.

$$Y = [(P_B - P)V_B]/[P(V - V_B)]$$

P_B is saturation pressure, P pressure of complex, V_B vol of complex at saturation pressure, and V two-phase volume at P. Y is a linear function of pressure for hydrocarbon systems. In the first place the experimental data can be adjusted to give the best straight line relationship, and then the derived values of Y can be employed for calculating new values for the relative vol of the two-phase system (V/V_B).

The results of studies on two samples are given in detail.

G. D. H.

50. A new look at the constant per cent decline curve. K. E. Gray. *Oil Gas J.*, 29.8.60, **58** (35), 67–74.—Confusion sometimes occurs between "loss ratio" and "decline." Loss ratio is the ratio of the reduction in producing rate over a given time interval to the rate at the beginning of that interval, and can never exceed 100%. A constant loss ratio implies constant per cent decline. True decline is a constant fraction of the instantaneous rate of production at any time, and can exceed 100%; it is the basis of the commonly used rate–time and rate–cumulative production graph. Loss ratio and true decline are the same only at vanishingly small time intervals; thus although the use of monthly loss ratios as monthly decline will only produce small errors, the use of yearly loss ratios for annual decline will give significant errors unless the annual decline is 5% or less. The mathematical properties of the two methods of assessing falling production are examined, and further examples of confusion are given.

J. C. M. T.

51. Mass attack launched against corrosion at well casings. E. McGhee. *Oil Gas J.*, 5.9.60, **58** (36), 163–4.—Cathodic protection is being applied to all 529 wells in the Fullerton field, W Texas, which has a serious casing corrosion problem where sour water in the San Andreas formation is penetrated at 4000–5000 ft. It is estimated that 8 amp/well will give protection to 6100 ft.

J. C. M. T.

52. Watch those mixed injection waters. L. C. Case. *Oil Gas J.*, 8.8.60, **58** (32), 92–5.—Plugging of pipe, formations, screens, and filters can result from the mixing of incompatible waters, harmless by themselves. Repairing damage from precipitation can be more costly than water treatment. Most common deposits formed contain barium, strontium, and calcium sulphates, calcium carbonate, iron sulphide, and iron oxide. Reactions between barium and sulphate ions is not complete except at very low pH, high temp, and several hours time. Solubility in chloride brines is higher than in dist water. Experiments show that under certain conditions harmless mixtures of barium and sulphate ions can be used. Anomalies in the behaviour of mixtures which might be expected to give other of the troublesome cpds listed above also exist. In all cases, chemical analysis followed by calculation is advised before making mixtures, tempered by field experience.

J. C. M. T.

53. Thermal characteristics of porous rocks at elevated temperatures. W. H. Somerton and G. D. Boozen. *J. Petrol. Tech.*, June 1960, **12** (6), 77–81.—Thermal diffusivities were measured on samples of sandstone, limestone, shale, and salt in the range of 200°–1800° F. There was a marked drop in thermal diffusivity with rise in temp, and this would be of importance in heat transfer calculations. The reliability of the values falls off at the higher temp, in part due to simplified calculation methods.

Thermal conductivities have been calculated and compared with steady-state conductivity measurements, there being satisfactory agreement at the lower temp.

Axial loading led to increase in conductivity in steady-state measurements. The effects of liq saturation were not examined, but previous work showed liq to increase the conductivity substantially. In dealing with underground problems, allowance must be made for heats of reaction.

G. D. H.

54. Utah's Aneth may halt close-spacing arguments. Anon. *Oil Gas J.*, 8.8.60, **58** (32), 75–7.—Testimony before the Utah Oil and Gas Commission establishing 80-acre well spacing for the Greater Aneth Area should help the industry to assess the best well density in other reservoirs. Data on which the testimony was based were available from over 400 wells and after over 55 MM brl oil had been produced. The field has an area of 50,000 acres and produces oil of 42°API gravity and 1·8 cP surface visc, from 40 ft of net pay in reefal Pennsylvanian rocks at *ca* 5600 ft. Structural relief is low. Average permeability is 20 mD, max is 2500 mD. Average connate water saturation is 21%. Original reservoir pressure

was 2200 psi and the bubble point 1730 psi. The predominant producing mechanism is solution-gas drive. Discovery was in 1956, and current production is *ca* 90,000 bd. Interference tests throughout the field, including some portions with 160-acre well spacing, and pressure tests in five specially drilled in-filling wells proved that the reservoir was in complete interconnexion vertically and horizontally and that 80-acre well spacing would drain it efficiently. J. C. M. T.

55. How to get top performances from your V-belt drives. A. E. Pohlmann. *World Oil*, July 1960, **151** (1), 120.—Multiple V-belt drives have several advantages in mechanical power transmission, and for max efficiency the belts must be matched, properly installed, inspected at regular intervals, and adequately stored when not in use. Belts can be matched by numbers, but new and used belts should not be mixed because of unequal load spread. Trouble-free drive can be ensured by cleaning oil and grease from sheaves and grooves, and removing nicks and burrs from grooves. Sheaves with badly worn grooves should be replaced, together with damaged bushings or bent shafts. The method of fitting belts is briefly described with diagrams. The belts should be stored under cool, dark conditions. C. A. F.

56. In New Mexico's Bisti field Sunray's LPG pilot test is paying off. T. W. Brinkley. *World Oil*, 1.8.60, **151** (2), 85.—An LPG pilot test in the Bisti pool, San Juan Basin, has shown that a further 6 million brl should be recoverable from the Central Bisti unit by applying miscible phase displacement to the area. It is planned to inject 935,000 brl of LPG in advance of natural gas for sweeping purposes over the unit area of 7000 acres. The pilot scheme covers 160 acres, and details of its operation during its two-year life are given, together with the reservoir characteristics, production data, and geology of the area. Production comes from Upper Cretaceous Lower Gallup sands at *ca* 5000 ft. Permeability and porosity of the pay sands are very variable, and there is stratigraphic trapping due to sand bar conditions. Tables show production statistics of the unit. C. A. F.

57. How to design a closed rotative gas lift system. Pt 1. H. W. Winkler. *World Oil*, July 1960, **151** (1), 116.—A closed rotative system involves the return of the total gas-out from the well to the suction of the compressor for compressing and gas lifting the well. After initial charging the only significant make-up gas is the fuel for the compressor prime mover. Such a system has the advantages of a central power plant, and these increase with the number of wells in the system. A simplified flow diagram of a closed rotative gas lift system for a single intermittent well is given. In designing the system it is necessary to estimate the daily injection gas requirement for the assumed injection gas pressure and a method is given. The approx compressor brake hp must also be calc together with the excess or make-up gas vol; the latter is based on the produced gas from the wells, fuel requirements of the compressor station, and any miscellaneous gas losses in the system. The design of a high pressure injection gas system is outlined together with a scheme for a low pressure gas gathering system. C. A. F.

58. Oil recovery in five-spot pilot floods. B. H. Caudle and I. G. Loncaric. *J. Petrol. Tech.*, June 1960, **12** (6), AIMME Tech. Paper No. 8116, 132–6.—A pilot flood will have a different flow system and sweep-out pattern from a full-scale flood.

Sand cemented with epoxy resin was used in a model employing X-ray shadowgraph techniques to show the sweep-out pattern. The model, 0·25 inch thick, had the injection well 6 inches from the producer, and the outside edge of the model was 18 inches from the injection well. Iodobenzene was dissolved in the injection fluid, which was an oil miscible with the oil in place, thereby keeping the effective permeability constant during each run. Comparison was made with a multi-well five-spot system. The mobility ratios were 0·1, 0·3, 1, 3, and 10. In most cases the pilot gave a more favourable recovery than the complete injection project. Predictions made by wrongly using the pilot data could be out by a factor of four. Correction factors have been developed. These apply to cumulative production and cumulative injection for various fractions of the produced stream that are injected material. G. D. H.

59. How Californians operate their water floods. Anon. *Oil Gas J.*, 22.8.60, **58** (34), 73–6.—California was slow to adopt water flooding owing to the prevalence of high-gravity oil and thick producing sections, but 84 reservoirs in 49 fields are now being flooded. Flooding commenced in 1944. Sources of injection water are the sea (66·6%), produced water (27·8%), well water (5·2%), and miscellaneous (0·4%). Sea water salinity is *ca* 18,000 ppm with turbidity of 1–25 ppm and pH 7·7–7·2. Produced water and well water have salinities ranging from 71 to 21,000 ppm, solids from 15 to 140 ppm, pH from 7·0 to 7·5, and oil from 0 to 100 ppm. All sea water is treated with 10–20 ppm of corrosion inhibitor, some is treated with a bactericide, nearly all is used unfiltered, and none is treated for scale control. Nearly half the produced water is used without filtration, *ca* half is treated for scale and half with bactericide; most is treated with corrosion inhibitor. Most well waters are filtered and some two-thirds are treated for corrosion and bacterial inhibition and scale control. The majority of filters use diatomaceous earth. Positive displacement IC-engined pumps are commonest, but electrically-driven centrifugals are gaining ground. Principal completion methods are use of uncemented liners with slots or round perforations, and cemented casings with gun or jet perforations. Acidizing is commonly used with success. The most serious problem encountered is liner collapse in unconsolidated sands. J. C. M. T.

60. Production at Chartrelles. (In French.) Anon. *Rev. Inst. franç. Pétrole*, 1960, **15**, 1022–7.—There are three reservoirs: R1 is 0·85–4·2 m thick, 13–18% porosity, 20–70 mD permeability, with 40–50% interstitial water; R2 is 0·7–1·75 m thick, 9·2–15% porosity, 25–1600 mD permeability, with 45–65% interstitial water; R4 is 3·1–7·25 m thick, 14–20% porosity, 400–1620 mD permeability, with 50–100% water. The oil is 0·85 g/cc, with 6 kg/cm² saturation pressure. The water contains 8–10 g/l solids. The oil/water contact is at −1606 m.

Wells are usually completed through perforations in 5½-inch casing. The initial pressure was 175·7 kg/cm² at −1600 m. Acidization has been tried with success. Proximity to the oil/water contact causes restriction of output, and this was 80 m³/day, with less than 10% water in April 1960. G. D. H.

61. Production at Chailly. (In French.) Anon. *Rev. Inst. franç. Pétrole*, 1960, **15**, 1019–21.—Production was found in the Dogger at 1667·5 m in 1958. A productivity index of 0·47 m³/day/kg/cm² was measured, and the well gave 15 m³/day without a choke. The well spacing is 44 ha. 16 producers had been drilled by the end of 1959, and four dry holes. The early wells took 65 days, and later wells 26 days to reach the top of the reservoir; then slim holes were drilled in *ca* 25 days.

The initial pressure was 174 kg/cm² at −1600 m. Two porous zones occur in the limestone; zone A is 3–8 m thick, 10–18% porosity, 40–600 mD permeability, with 30–50% interstitial water; zone D is 3–6 m thick, 10–15% porosity, 20–300 mD permeability with 45–50% water. A tight fractured zone between has oil in fissures. An oil/water contact

occurs at −1609 m, the transition zone starting at −1605 m. The oil is 0·849 gm/cc, with 0·46% sulphur. The cumulative production was 42,000 m³ at the beginning of March 1960.
G. D. H.

OILFIELD DEVELOPMENT

62. World drilling. Anon. *World Oil*, 15.8.60, **151** (3), 92.—Active drilling outside the U.S.A. and Canada in 1960 is expected to increase the number of well completions by *ca* 7% over 5043 completions in 1959. U.S.A. completions are expected to decline to 46,324 compared to 49,331 in 1959, a 6·1% fall; and in Canada completions in 1960 should be 2620, a fall of 8·3% from 1959. Drilling outside these areas is particularly active in Mexico, Trinidad, Argentina, and Africa. Drilling in Venezuela continues to decline, and completions in 1960 should drop this year to 440 from 707 in 1959. The boom in Africa is centred in Libya, where 100 completions are forecast, making a total of 511 for N Africa. Drilling rates are expected to remain about the same in the Middle East.
C. A. F.

63. World crude reserves. Anon. *World Oil*, 15.8.60, **151** (3), 95.—World crude reserves for the end of 1959 were estimated at 11,005,370,000 brl, 4·5% higher than the estimate for the end of 1958. Middle East reserves were raised by 3·2% during the year to 157,946,000,000 brl, making 61·7% of the world's total. Communist countries hold *ca* 9·6% of the world's total. Kuwait holds the largest reserves, 60 billion brl, and is followed by Saudi Arabia, 48 billion brl. U.S.A. reserves are *ca* 32 billion brl, Russia 23 billion brl (est), and Persia 22 billion brl. A table gives proved crude oil reserves by countries and regions for 1959 and 1958, together with production and ratios of reserves to production.
C. A. F.

64. World crude production. Anon. *World Oil*, 15.8.60, **151** (3), 96.—World crude production is expected to average 20,458,000 bd in 1960, 5% higher than in 1959, which in turn was 7·7% higher than in 1958. There is active progress in developing production in countries outside the U.S.A., such as Argentina, Brazil, Chile, W Germany, the Netherlands, French colonies, and Japan. In these areas demand exceeds domestic supply. Some levelling off of output is expected in some large exporting countries, but there has been no significant drop in such countries as Kuwait and Venezuela. The largest increases in production are being made in SW Africa in Gabon, Nigeria, Angola, and Congo, where fields are being actively developed. A table shows world crude production and producing wells by countries, 1959 and 1958, and cumulative production through 1959.
C. A. F.

65. World demand and supply. Anon. *World Oil*, 15.8.60, **151** (3), 94.—World demand for crude oil, natural gasoline, and lease condensates increased by 1,253,000 bd in 1959 to 20,473,000 bd, 6·5% higher than in 1958. Supply exceeded demand by 117,500 bd and over-supply is becoming a serious problem in world markets, with the depressing of prices and increasing competition for markets. Over-supply conditions are expected to last for at least six years, and this is reflected by a slackening of interest in nuclear power developments in ECM countries. The future effect of Saharan crude is uncertain, and estimates from the Hassi Massaoud field are being lowered, due to poor reservoir characteristics of the pay. Excess of supply over demand in the U.S.S.R. has encouraged exports.
C. A. F.

66. Nebraska hunters eye "the other side." F. J. Gardner. *Oil Gas J.*, 12.9.60, **58** (37), 159.—Wildcatting in SW Nebraska has been encouraged by successful drilling along the W flank of the Cambridge Arch; Cambrian fields have recently been found in Red Willow County. New exploration is to be carried out on the E flank of the arch, which is barren country, sparsely drilled.
C. A. F.

67. Alaska—the next big oil state? T. A. Zappa. *Oil Gas J.*, 22.8.60, **58** (34), 128.—Over one-third of Alaska, which is over twice the area of Texas, is thought to be potentially oil-bearing. Possible provinces in the state are scattered over many basins which aggregate 125 million acres. Oil has been known in Alaska since 1853, and wells were first drilled at the beginning of the century. In recent years oil has been found on the Kenai Peninsula, where a well in 1957 found 900 bd; reserves are estimated at 100 million brl min; by May 1960 seven oil wells and two dry holes had been drilled. Gas has also recently been found in the area. Oil and gas development in Alaska offer excellent geological prospects and there are many economic advantages over foreign and domestic oil: important restrictions do not apply, royalty terms are favourable, there is political stability, and there are immediate markets. There is not proration, and it is thought that exploration costs may become lower than in the U.S.A.
C. A. F.

68. Petroleum developments in Mexico in 1959. F. Mina. *Bull. Amer. Ass. Petrol. Geol.*, 1960, **44**, 1000–13.—As in previous years, exploration activities were concentrated mainly along the coastal plain of the Gulf of Mexico, where the principal sedimentary basins occur. These are, from N to S, the Tertiary Embayment of NE Mexico, the Mesozoic embayments of the Tampico and Veracruz regions, and the Tertiary Embayment in the Isthmus and Tabasco.

Geological and geophysical exploration activities were continued in other prospective areas, with two seismic crews in the Sebastian Vizcaino Embayment in Lower California, one gravity crew in NE Chihuahua, and two more in E Yucatan.

441 wells were drilled during the year as compared with 379 completed in 1958, with an average depth of 7035 ft as compared with 6958 ft. The average depth for exploratory holes was 7391 ft, as compared with 8140 ft for the previous year. Of the 133 exploratory holes drilled, 42 were successful (31·6%); of the 82 new-field wildcats drilled, 11 were successful, or 13·4%.

Crude oil and dist production increased by 9·5% and gas production by 79·7% over 1958.
E. N. T.

69. Petroleum developments in S America and Caribbean area in 1959. E. W. Clark. *Bull. Amer. Ass. Petrol. Geol.*, 1960, **44**, 1014–57.—Crude oil production in S America, including the island of Trinidad, averaged 3,244,900 bd during 1959, representing *ca* 17% of the world's production during the year. There were appreciable increases, as compared with 1957, in Argentina, Brazil, Colombia, and Trinidad, totalling 113,100 bd; this was offset by a decrease of 69,000 bd in Venezuelan production. The consumption of petroleum in S America, on a crude-equivalent basis, amounted to roughly one million bd; the area was therefore a net exporter of more than two million bd of petroleum during 1959.

Exploration activities were maintained at a high level in Brazil, Argentina, Bolivia, and Colombia, but decreased considerably in Venezuela, where large concession areas were voluntarily surrendered.
E. N. T.

70. Petroleum developments in Middle East and adjacent countries in 1959. H. Hotchkiss. *Bull. Amer. Ass. Petrol. Geol.*, 1960, **44**, 1144–78.—In the Middle East countries in 1959, petroleum production totalled 1,678,553,000 brl, an average of 4,598,606 bd against 1,559,533,000 brl, an average of 4,272,884 bd, in 1958.

In Pakistan, production totalled 2,335,000 brl, an average of 6398 bd against 2,271,379 brl, an average of 6207 bd, in 1958; in India production is estimated to have totalled 3,467,000

brl, an average o 9500 bd, against an estimated production in 1958 of 3,102,000 brl, an average of 8500 bd.

Three new districts were opened for bidding in Iran, but the only important concession granted was in the Yemen. Renewed interest was shown in Lebanon. Drilling began in three offshore licences in the Persian Gulf during 1959.

In Iraq, Iran, Kuwait, Saudi Arabia, and India, expansion in production, pipeline, and/or terminal facilities was under way or completed; refining capacity is being increased in Turkey and India. E. N. T.

71. Petroleum developments in Africa in 1959. H. D. Hedberg and J. D. Moody. *Bull. Amer. Ass. Petrol. Geol.*, 1960, **44**, 1101–43.—Petroleum exploration, development, and production activities continued at high levels throughout 1959; production increasing by 36% over the preceding year. This increase came largely from Algerian Sahara, Nigeria, and Gabon.

14 new discoveries were made in Libya, nine in Nigeria, seven in Algerian Sahara, two in Angola, and one each in Egypt, Cameroons, and Senegal. Exploratory wells were completed, but without success, in Congo, Ivory Coast, Kenya, Madagascar, Morocco, Somalia, British Somaliland, Tanganyika, Tunisia, and Zanzibar. Geological–geophysical exploratory work was most extensive in Libya and Algeria. Concession activity was particularly great in Algeria and Libya, and in Spanish Sahara. E. N. T.

72. Nigeria gets set to move into international markets. E. L. Lomax. *Oil Gas J.*, 5.9.60, **58** (36), 216.—The history of oil discovery and development in Nigeria is outlined. The search began in 1937 in the Delta region, but until 1956 no significant shows had been found. Following the discovery of commercial oil at Oloibiri in the Delta, two further fields have been found in the area at Bomu and Afam, and 60 wells had been completed by the end of 1959. *Ca* one-half of these found oil or gas. Fields have also been found in the interior at Ebubu (1958), Okoloma (1959), and Elenwa (1959). Field operations are noted. C. A. F.

73. Petroleum developments in Far East in 1959. G. F. Kaufmann. *Bull. Amer. Ass. Petrol. Geol.*, 1960, **44**, 1179–204.—All producing areas of the Far East showed an increase in crude oil production in 1959, with the exception of Java, Netherlands New Guinea, and perhaps Sakhalin. Total production in 1959 was 221,662,802 brl, compared with 190,375,439 brl in 1958, a gain of *ca* 18%.

Gas production is growing in importance in the petroleum developments in the Far East, and important discoveries have been made in Japan on the W coast of the island of Honshu. Russia will compete with non-Communist producing areas in supplying some Far East markets with both oil and gas.

Two small producers, the first to be rated as commercial oil wells, were drilled in the Philippines during 1959. E. N. T.

74. Petroleum exploration and production in Europe in 1959. R. E. King. *Bull. Amer. Ass. Petrol. Geol.*, 1960, **44**, 1058–101.—In W Europe oil production rose to a rate of 256,700 bd or 7·7% over that of the preceding year. The increase was chiefly due to a gain in Germany of 11% to a daily production of nearly 100,000 brl. The most impressive gain was 23% in Yugoslavia, followed by France with 17% and Italy with 10%. Austrian production declined again by 13·3%.

Exploratory drilling continued at a high rate in France, important discoveries being made in the Paris and Aquitaine Basins. In Germany some apparently significant gas discoveries were made; exploratory drilling declined. In Italy some interesting exploratory wells were drilled in the Apennines, and gas discoveries were made in the S part of the peninsula and in the Po Valley. In the Netherlands, production in the Schoonebeek field further declined, but there was a sharp gain from small fields in the W part of the country. Numerous unsuccessful exploratory wells were drilled in Denmark, Spain, Portugal, and European Turkey; further operations were suspended in Denmark and Portugal. In the U.K. oil was found in the Jurassic for the first time, at a well in Dorset on the S coast.

Plans were made for drilling in Switzerland in 1960. Negotiations for concessions were made in Belgium, Eire, and Greece. Some data on production and exploration in the Soviet Union are included in the paper. E. N. T.

75. British oil hunt moves offshore. Anon. *Oil Gas J.*, 15.8.60, **58** (33), 196.—Geophysical exploration has recently been carried out off the SW coast of the Isle of Wight for the purpose of investigating the offshore extension of a large anticline. This anticline is thought to be oil-bearing, and the results of the seismic work will determine whether it should be drilled. Offshore seismic work has also been carried out off the Yorkshire and Dorset coasts. Field operations are briefly noted. C. A. F.

TRANSPORT AND STORAGE

76. Feasibility of underground storage of liquefied methane. D. A. Flanagan and P. B. Crawford. *J. Petrol. Tech.*, June 1960, **12** (6), 73–6.—The design of low-temp storage vessels has been improved, and they can be designed for various evaporation rates. To shave peak gas demands desirable rates may be 0·2–1·5%/day. Surface storage may cost $3000–$20,000/MMcf. Underground storage would offer benefits.

The heat flux from a spherical cavern charged with liquefied methane can be calculated. Temp distribution and heat flux vary with size, time, and the rock properties. Very steep temp gradients are indicated. For storage near atmospheric pressure *ca* 10 Btu will be needed to evaporate 1 cu ft of methane. Insulating walls will reduce heat flux and evaporation rate; the latter could be reduced by factors of 2–10 for small caverns by 6 inches of insulation.

Rocks may not be suitable for spherical cavities. Usually it costs less to excavate one large cavity than the same vol in small openings. LPG storage at 300–500 ft has involved costs of $4 to $2·5/brl for volumes of 100,000–500,000 brl, respectively. Contamination would be small; water, CO_2, H_2S and NH_3 would be frozen before reaching the storage cavern.

Where liq methane is moved by tanker an uninsulated cavern would seem suitable. The first few months of operation will be used to cool the cavern. When methane has to be liquefied to shave peak gas demands, insulation may be needed. Insulated tanks in caverns would be possible and safer. G. D. H.

77. Product-pipeline terminal is remote controlled. D. T. Durrant. *Oil Gas J.*, 29.8.60, **58** (35), 75–7.—A new unattended pipeline delivery terminal is described. The pipeline is an 188·5-mile system between Sarnia and Toronto with two 6·7-mile spur-line take-offs. It has three main-line pumping stations and seven delivery terminals. A turbine meter is used for local measurement, flow control, and remote telemetering of flow rates, and the terminal makes heart-cut deliveries from 30,000–100,000 brl batches. The terminal

has proved relatively free of maintenance difficulties, and on the basis of experience gained a second remote-controlled delivery terminal has been engineered. A. D. S.

78. Pipeline delivers sulphuric acid. K. D. Fetrow. *Oil Gas J.*, 29.8.60, **58** (35), 78.—99% sulphuric acid is being delivered continuously from a chemical plant situated one mile away from the refinery. Above ground piping is Schedule 80 carbon steel, and the underground portion is ductile-iron pipe cased in a steel sleeve. The piping was designed for viscous flow to combat the excessive corrosion caused by turbulence. Temp is kept within the limits of 60° and 140° F by both electric and steam heating. Flow rates are metered by magnetic flowmeters, and statistical analysis shows that there is a 95% assurance that aggregate monthly strength of the acid will not vary more than ±0·5%. A. D. S.

79. Cut turbulence and reduce noise. Anon. *Oil Gas J.*, 19.9.60, **58** (38), 125–8.—Methods of reducing turbulence and therefore noise in natural gas pipelines are considered. These are: maintaining max gas velocities at 85 ft/sec, burying headers, fitting a sweep lateral in place of welding tees, and choosing and siting the correct type of regulator. A. D. S.

80. Use of glass-reinforced plastic pipe may increase. R. M. Levy. *Oil Gas J.*, 19.9.60, **58** (38), 96–8.—Glass-reinforced plastic pipe has a number of characteristics which favour its use. It is corrosion-resistant, has high strength, light wt, improved flow characteristics, resistance to paraffin deposition, low thermal and electrical conductivity, and further is easy and economic to install. The structure of these pipes and their manufacture is considered, and methods of pipe testing, such as sustained pressure tests, are discussed. This type of pipe is at present used in crude-gathering lines, salt-water disposal lines, and water-flooding operations. Limited applications can be found in refinery offsites and aboard tankers. A. D. S.

REFINERY OPERATIONS

REFINERIES AND AUXILIARY REFINERY PLANT

81. The systematic prediction of refinery utilities. F. P. Alban. *J. Inst. Petrol.*, 1960, **46**, 273–84.—Utilities are classified under three main headings: normal utility consumptions, which are confined to those consumed directly in the process when fulfilling the quantity and quality process guarantees; intermittent utility consumptions, which include requirements for standby and infrequently operated equipment; and emergency utilities for dealing with plant upsets and fire fighting. Under these three categories are tabulated the main utility users likely to be encountered in refinery practice. The basic calculation of utility values is discussed, confining the examples to types of pumps, compressors, and drivers which are the main consumers in a refinery.

A chart is presented illustrating the functional type of organization, in which, after release of process and project design data, the subsequent mechanical analytical work is carried out by specialist divisions. The work covered by the process engineering and project departments and the specialist divisions is detailed and the responsibilities of the project are summarized.

The importance of a specialist group for handling utilities is emphasized. This will lead to a better understanding of the problem and tend towards greater accuracy in the design and prediction of utilities.

Finally, to illustrate in detail some of the basic calculations and assumptions, the balance sheets, and other features of utility predictions, a hypothetical atmospheric/vac crude dist unit has been used as a basis for reference. A. D. S.

82. New plastic packing for trickling filters. Anon. *Oil Gas J.*, 12.9.60, **58** (37), 122–4.—A new plastic packing, marketed as Poly-Grid, has been designed to replace the rock bed now commonly used in trickling filters. Features of this packing include extended surface, splash grids for air and water redistribution, and a high strength-to-weight ratio. Pilot plant studies with this packing show consistent removal of 99% of phenol in waste waters at loadings up to 32 lb phenol/Mcfd, that effluent contains less than 0·5 ppm sulphides, and that the packing remains completely free from plugging or bridging by biological slime. At the end of one year's operation the packing was in excellent condition, showing no deterioration or cracking, and a flexure test showed strength to be essentially the same as for new packing. A. D. S.

83. How to design safe flare stacks. 2. J. D. Hajek and E. E. Ludwig. *Petrol. Engr*, July 1960, **32** (7), C44.—Problems of blowout (upper limit of flame stability), limits of inflammability, and heat damage from flame radiation are considered. A detailed calculation is carried out to make clear the application of the discussions developed in this and the earlier part. A complete bibliography on the subject is available. G. D. F.

84. World-wide survey of petrochemical plants outside the U.S. R. B. Bizal. *Oil Gas J.*, 5.9.60, **58** (36), 129–50.—This report of petrochemical plants outside the U.S.A. lists them alphabetically both by countries and companies. It includes all existing plants and planned projects, showing raw materials, products, and capacities. A. D. S.

85. 1960 survey of petrochemical plants in the U.S. R. B. Bizal. *Oil Gas J.*, 5.9.60, **58** (36), 116–28.—This survey lists companies alphabetically with headquarter addresses and includes a complete plant-by-plant report showing raw materials, capacities, and products. For easy reference to new projects, all such constructions are indicated with dot symbols. A. D. S.

DISTILLATION

86. Problems in pure naphthalene recovery by distillation. (In German.) C. Gewers. *Erdöl u. Kohle*, 1959, **12**, 231–6.—Dist recovery of pure naphthalene set pt >79° C is discussed. Theoretical observations on separation of tar bases and acids by H_2SO_4 and soda lye wash in crude naphthalene are made. In this hydrolysis and distribution coeff play an important part. A washing const is derived which describes distribution of tar bases and acids between oil and acid or lye phase. Tests with a Saar and a Spanish crude naphthalene showed that tar bases are washed out much more easily than tar acids. H_2SO_4 permitted saturation with the acids only to $\frac{1}{2}$. The pyridine–H_2SO_4 obtained with increasing saturation tends to emulsion formation, sulphonates being formed by secondary reactions. Influence of washing on dist recovery of pure naphthalene was investigated by fine fractionation of crude naphthalene with varying cont of tar bases and acids. In almost all cases it has proved that separation of the tar bases and acids as extensive as possible leads to increased yields of 79 set pt naphthalene. Thereby the rise of the set pt

is steeper. Accordingly, the amounts of 79 mp fractions are higher and the amounts of first fractions with set pt <79° C smaller. Six refs. R. T.

87. Investigation of optimum conditions in extractive distillation. (In French.) L. Le Bec. *Chim. et Industr. (Génie Chim.* suppl.), 1960, **84**, 41–54, 88–99.—Essential features of industrial plant defined. Outline of general methods of dist column calcn, based on material and enthalpy balances. In absence of sufficient thermodynamic data various workers have developed approx methods, such are described. Effect of constructional and operational parameters on economic balance are studied and properties of most suitable third material are indicated; choice of this may be guided by thermodynamic (assessment of activity coeff) or structural (polarity, mol association) considerations. Final choice requires expt determination of vap–liq equilibria.

(Author's summary.)

SOLVENT EXTRACTION AND DEWAXING

88. Oil dephenolizing with alkali acetates. (In German.) G. Kowalski, L. Lewicki, and B. Los. *Erdöl u. Kohle*, 1959, **12**, 241–5.—Extraction conditions for oil dephenolization by ammonium and potassium acetates are investigated. Phenol extraction does not result by linkage to free alkali, but residual valencies of the acid residue are decisive, which lead to formation of mol cpds of the salts used with the phenols. The same reaction mechanism is accepted for the known dephenolizing of oils with soln of alk-reacting alkali salt soln of weak inorg and org acids. For acetate soln regeneration from the extract, phenol extraction with solvent, *e.g.* benzene, is proposed. In this working up, predilution of the extract with H_2O for separating the dissolved oils may be advantageous. R. T.

CRACKING

89. "Iso-Kel"—development of an isomeric catalyst and process. (In German.) H. Heinemann *et al.* *Erdöl u. Kohle*, 1959, **12**, 228–31.—In the quest for higher ON from the relatively few processing possibilities for improving light straight-run gasolines (C_5 and C_6 paraffins), isomerization of branched paraffins shows the greatest promise. Isomerization of paraffins over Pt reforming cat is not selective and leads to loss of liq products. A cat of new composition has been developed which shows greater activity and higher selectivity, and effects isomerization essentially without cracking and aromatization. The "Iso-Kel" cat is based on a noble metal other than Pt, has tenfold the activity of Pt–alumina-cat, and is considerably more selective. Results of tests are given in tables and curves. The cat has long life without regeneration, its activity is not impaired by regeneration. It is sensitive to the same materials as Pt cat. Cumulative effect of S-cpds is not observed. R. T.

HYDROGENATION

90. H-oil process promises to improve quality of distillate feed. M. C. Chervenak *et al.* *Oil Gas J.*, 29.8.60, **58** (35), 80–7.—In the H-oil process, a mixture of oil and hydrogen is fed upflow into an ebullating bed of cat. The motion of the cat, together with high oil velocity, results in good contact between oil, hydrogen, and cat. Advantages of this method are that the ebullating bed is free from pressure-drop problems, and allows continuous replacement of cat, which in turn permits the refiner to market furnace oil of constant quality. Internal liq recycle is an important feature of this process, particularly on stocks where heat evolution is high. Operating at 1500 psig, the furnace oil unit is flexible with respect to block operation with feeds in the cat feed and heavier boiling ranges, the quantity of cat is only 10–20% of that in fixed-bed units at conventionally used pressures, cat make-up rates are such that regeneration facilities are unnecessary, and nitrogen removal will be greater for a given extent of desulphurization. It is shown that colour, gum, and aging properties of furnace oils refined by this process are satisfactory, even when the charge stock has a high content of cracked components and a relatively high nitrogen content.

A. D. S.

CHEMICAL AND PHYSICAL REFINING

91. Reduce operating costs of MEA gas treaters. Anon. *Oil Gas J.*, 12.9.60, **58** (37), 118–20.—Process conditions for the treatment of sour gas with an aq soln of monoethanolamine for removal of H_2S and CO_2 are considered. The process flow is shown diagrammatically and amine-soln circulation rate, absorber size, reboiler heat load, and still-column size are discussed. Factors that affect operating costs, such as fuel, power, reagents, operating labour, maintenance, and lost production due to down time are critically examined and suggestions are made for keeping such costs to a minimum.

A. D. S.

SPECIAL PROCESSES

92. Electrochemical reduction of organic substances in the heterogeneous system. (In German.). W. Fuchs and O. Veiser. *Erdöl u. Kohle*, 1959, **12**, 223–8.—Synthesis of aliphatic hydrocarbons occurs by way of elec reductions, oxidn, cathodic and anodic couplings, and by substitutions. Use of electrochem processes in org chem was limited by insolubility of the substances in aq solvents and their exceptionally low diffusibility. However, the passage of electrons to solid material particles in an electrolyte liq must be possible with intimate contact between electrode and org substance, and with correspondingly high energies. Results presented indicate the possibility of electrochem reduction in the heterogeneous solid–liq-phase mixture, in that undissolved org cpds and complex natural products, wood, coal, etc., can be brought to reaction at the cathode in aq electrolyte soln. An assumption is the development of effective electrolytic cells which permit delivering the necessary high energy at const potential. Knowledge gained by studying different variables is applied to electrolysing cell construction for carrying out discontinuous and continuous processes. Salient features of the illustrated cells are discussed, *e.g.* electrode materials and surface condition, diaphragms org and inorg, electrolytes depending on the type of material to be reduced, cell conformation, etc. Particular ref is made to cells in which the energy at both anode and cathode is used simultaneously to bring about reduction and oxidn. Theories of anthraquinone reduction are presented. 12 refs. R. T.

METERING AND CONTROL

93. A new look in control laboratories. W. L. Pursell. *Oil Gas J.*, 22.8.60, **58** (34), 82–7.—A recently constructed refinery control lab of some 15,000 sq ft floor area is described, the building being equipped with central, all-electric heating and air conditioning. The lab rooms, which are grouped around the central machine and service area, are designed for black and clean oil testing, knock rating, and analysis. Separate rooms are provided for LPG, cat, and hydrogen fluoride testing, and for chromatographic and low temp work. Safety features include a separate fire alarm for the building, a higher air pressure in the halls to help prevent spread of fumes and

fire, and the provision of at least two exits for each lab as far removed from each other as is practical. A. D. S.

94. LACT saved money in Four Corners. W. J. Fairbanks. *Oil Gas J.*, 12.9.60, **58** (37), 107–12.—Experience with LACT systems in the Four Corners area show that such systems require less investment than conventional batteries when installed on large producing leases with minimum storage. Operating benefits cannot often be substantiated because of difficulty in placing money values on benefits such as improved oil gravity, reduced tank cleaning, and ultimate future savings. As indicated by experience in this area, labour savings of LACT tend to be small and may be offset by added maintenance. Highly reliable and accurate performance can be obtained from a positive-displacement metering-type LACT system and over 9 million brl have been metered from nine units without serious breakdown and with a cumulative measurement error of less than 0·01%. A. D. S.

PRODUCTS

CHEMISTRY AND PHYSICS

95. Thermal conductivity measurements on oils. R. W. Powell and A. R. Challoner. *J. Inst. Petrol.*, 1960, **46**, 267–71.—In a recent publication doubts were expressed about the accuracy of thermal conductivity determinations made in the guarded hot-plate apparatus. Check observations were made in a thermal conductivity apparatus of the plate type and showed that no errors of the kind suggested were present. Thermal conductivity data are presented for several samples of transformer oils, and it is concluded that results on present-day transformer oils differ appreciably from those of oils available 30 years ago. A value of 0·00118 ± 0·00003 J cm/cm² sec ° C now seems appropriate for the temp range 20°–60° C. A. D. S.

ANALYSIS AND TESTING

96. The determination of water in gaseous hydrocarbons: Fischer reagent method. The Petroleum Gases Panel of the Institute of Petroleum. *J. Inst. Petrol.*, 1960, **46**, 294–8.—This method is applicable to concn of water from a few ppm up to 2 mg/100 ml of hydrocarbon gas. The gas sample is passed through a small titration vessel containing ethylene glycol and a known excess of Karl Fischer reagent. The water content is calculated from the vol of gas required to react with the reagent. The apparatus, materials, preparation of sample, procedure, and calculation are fully detailed and the repeatability is given as 1, 5, and 10% of mean for water contents in mg/100 ml gas of 2, 0·03–2, and 0–0·03. A. D. S.

97. Sensitive spot test for nitrogen compounds in petroleum fractions. P. V. Peurifoy and M. Nager. *Analyt. Chem.*, 1960, **32**, 1135–7.—The total N content of petroleum fractions can be estimated by means of the heat-stable colour produced by spraying a spot of the sample on filter paper with tetracyanoethylene. Greater sensitivity is obtained by using the ring oven. The sample spot is eluted with 60% acetic acid to a circle of 11 mm radius, heated to 110°, cooled, and sprayed. The centre spot is used for comparison. In both techniques the sprayed spot is heated to 110° to destroy other coloured products. The limit of detection is 0·5 ppm and the accuracy ±20 ppm. G. B.

98. Colorimetric determination of the vanadium content of residual oils by 8-quinolinol. R. J. Nadalin and W. B. Brozda. *Analyt. Chem.*, 1960, **32**, 1141–3.—The method described is more sensitive than the tentative ASTM phosphotungstate method but slightly less precise. The ash from 1–2 g of oil containing 10–100 μg of V is dissolved in HCl, evaporated to dryness, and re-dissolved in dil H_2SO_4. The V is oxidized with $KMnO_4$ and the pH is adjusted to 5·5. A buffered soln of Ca versenate and a soln of 8-quinolinol in $CHCl_3$ are added and the absorbance of the $CHCl_3$ layer is measured at 550 mμ. With some oils it is necessary to electrolyse the soln of the ash. The pH and the concn of the reagents are critical. G. B.

99. Gas chromatographic determination of C_6, C_7, and C_8 olefins according to their carbon structures. K. H. Nelson, W. J. Hines, and D. E. Smith. *Analyt. Chem.*, 1960, **32**, 1110–14.—These olefins are too numerous to be separated by gas chromatography, but can be determined as groups according to their structures. The olefins are removed from one sample (ASTM Method D 1019–58T) and the saturated components of the sample are determined. In another sample the olefins are hydrogenated and the saturated components again determined. The differences between the two sets of results (calc to whole sample) represent the olefins having the carbon structures of the corresponding paraffins and naphthenes. G. B.

100. Direct determination of C_3 to C_5 hydrocarbons in olefinic and non-olefinic gasolines by gas–liquid chromatography. D. D. Zakaib. *Analyt. Chem.*, 1960, **32**, 1107–10.—The hydrocarbons containing from three to five C atoms can be separated and determined by gas–liq chromatography on a single column 16 ft in length. The first 4 ft of the column is packed with di-2-ethylhexyl sebacate and the remainder with tri-tolyl phosphate saturated with $AgNO_3$. Both stationary phases are supported on firebrick. The carrier gas is He flowing at 60 ml/min and the column temp is 30° C. The total of hydrocarbons with > five C atoms is recorded as a single peak by back-flushing the column. The method is suitable for the analysis of the light ends of petrol. Tables give retention times and relative liq vol response per unit chromatographic peak area. G. B.

101. Quantitative determination of traces of vanadium, iron, and nickel in oils by X-ray spectrography. C. W. Dwiggins, Jr and H. N. Dunning. *Analyt. Chem.*, 1960, **32**, 1137–41.—The preparation and use of a Co–Cr internal standard is described. An emission-absorption method is described for cases in which an internal standard cannot be used. G. B.

102. Separation and infra-red spectroscopic determination of non-ionic octylphenoxyethanol additives in gasoline. R. M. Sherwood and F. W. Chapman. *Analyt. Chem.*, 1960, **32**, 1131–2.—Octylphenoxyethanol cpds used in petrol as anti-icing agents can be determined to within 3% in concn of 100 ppm by the procedure described. The sample (50 ml) is evaporated to 4 ml on a steam bath under N and the residue is dissolved in CCl_4 and passed through a 7-ml column of activated alumina, which absorbs the octylphenoxyethanol cpd. The column is then washed with a soln of pyridine in CCl_4 (1 : 19) to remove interfering substances. The octylphenoxyethanol cpd is eluted with a soln of *iso*propyl alcohol in CCl_4 (1 : 4) and determined by its ir absorption at 8 μ. G. B.

103. Research on engine lubricants. Anon. *Auto. Engr.*, 1960, **50**, 368–74.—A description is given of the new lab which has been built for the engine testing of lubricants at

Shell's Thornton Research Centre. Pallet engine beds are extensively used in the lab to permit the rapid changing of complete beds during a test programme, and these beds, together with the deep bed types used for larger engines, are described in detail. Other sections of the article are devoted to the general layout of the building, services, and ventilation. D. W. G.

104. Investigation of a crude oil from Rijswijk by The Hague. (In German.) C. Boelhouwer *et al.* *Erdöl u. Kohle*, 1959, **12**, 218–22.—A report is presented on the structural analysis and characterization of a Dutch mineral oil. Structural analysis of the lower-bp fractions was determined by chromatography. Higher-bp fractions of the crude oil bp >150 and their hydrogenation products were investigated by suitable graphic-statistical analytical methods. By the *n–d–M* method *n–d* and mol wt were evaluated. By the *v–n–d* method and a visc-nomogram-method—with val for kin visc *v–n* and *d* are calc. Existence of a significant relationship was established by means of physical data of the oil fractions, between several physical const and chem structure of the fractions. In many cases these relationships made possible determination of important physical properties with the same accuracy as by direct determination. 15 refs. R. T.

GAS

105. Natural gas supply for Whitby. Anon. *Engineer, Lond.*, 1960, **210**, 552–4; *Fluid Handl.*, 1960, 285–9.—Two wells, closed pressures 1700/1900 psi, capable of yielding, from 4200–4800 ft, $4{\cdot}5 \times 10^6$ ft^3/day; reserves estd $1{\cdot}5 \times 10^9$ ft^3. Cal val 1000 Btu/ft^3. Gas piped six miles and reformed at 91% efficiency to H_2/CO then cold-enriched with CH_4, yielding gas of sp gr 0·54, cal val 500. Three reformer units at 625,000 scf/day each; Ni cat tolerating total S up to 0·5 g/100 scf; one well has H_2S, which is removed in oxide purifier. Tetrahydrothiophen odorant. Butane storage as stand-by for reformer plant. Flow diagrams of well-head arrangement and reformer. V. B.

ENGINE FUELS

106. Airport features fixed-hydrant fuelling. J. P. O'Donnell. *Oil Gas J.*, 26.9.60, **58** (39), 211–12.—A consolidated underground fixed-hydrant fuelling system will be installed at the Chicago–O'Hare Airport to handle 600 million gal pa. It will be a single system handling the fuel of many suppliers, and will cost in excess of $6 million. Design criteria for this system include max safety, fuel-quality control, preservation of brand identity, short fuelling time, dependability, and flexibility. Essentially this installation will consist of the hydrant system's bulk-fuel tank farm, satellite fuel storage, fixed hydrants on airport aprons with provision for future hydrant installations at hangars, and the system's transfer piping with its related pumping, filtering, and control equipment. A. D. S.

GAS OIL AND FUEL OIL

107. Experimental boiler for fuel oil research. K. J. Mackenzie *et al.* *Engineer, Lond.*, 1960, **210**, 548–51.—Water tube test boiler adjoining BP's Kent refinery (which absorbs steam generated). 20,000 lb/hr, 350 psig, 1200° F, dist water feed. Cutaway view and full description. Fuel up to 6000 sec R_1/100° F usable, deliverable at 500 psig. Fuel storage 750,000 gal and 150,000 gal, for prolonged runs on uniform fuel. Problems to be surveyed include conversion solid to liq, deposition of corrosive ash on steam superheater, cold surface corrosion from SO_3 in combustion gases. V. B.

108. Combustion laboratory at Egham. Anon. *Engineer, Lond.*, 1960, **210**, 658–9.—Illustr description of Shell International's new facilities for work on fuel behaviour and development of new fuels and combustion techniques. Equipment includes four nozzle testing rigs (one for determining particle size by a wax-freezing technique) and LPG burner (turn-down ratio >100 : 1). V. B.

LUBRICANTS

109. The effect of additives on the water induced pitting of ball bearings. L. Grunberg and D. Scott. *J. Inst. Petrol.*, 1960, **46**, 259–66.—A four-ball rolling test was used to determine the tendency of lubricants to cause pitting failure, and the detrimental effect of water was demonstrated. This effect of water can be counteracted by the addition of *iso*amyl alcohol to the lubricant or by the use of a de-watering agent such as an imidazoline derivative. In contrast to this, surface-active agents such as oleic acid and triethanolamine behaved differently. In the absence of free and undissolved water and under conditions of supersaturation, these additives gave almost identical pitting times. It was concluded that *iso*amyl alcohol and the imidazoline derivative prevented action by the water dissolved in the oil and thus were acting within the oil phase. Oleic acid and triethanolamine, on the other hand, produced an adsorbed monolayer on the ball surfaces, giving pitting time independent of the degree of water contamination. The mechanism of "adsorption fatigue," suggested by Rebinder, seems to apply in the presence of surface-active agents. A. D. S.

110. The hydrodynamic effect between approaching surfaces—its influence on surface profiles during plastic deformation. L. H. Butler. *J. Inst. Petrol.*, 1960, **46**, 289–93.—Compression tests were carried out on 1-inch dia × 1-inch long cyl mild steel specimens using flat contact dies. Die to metal interfaces were both unlubricated and lubricated with high visc fluids and the moving die approach speed controlled at 1 inch/min and 9 inches/min. Face profiles were measured before compression and after the specimens had become *ca* 0·9 inch long. The results of this work give support to the previous theoretical hypothesis (*cf* Abs **1346**, 1960) that continuous lubricant films may be present during bulk metal deformation processes, even when geometrical configurations of the tool and metal surfaces are apparently unfavourable and strain rates are moderate. The consequences of such films are discussed with reference to the magnitude and constancy of values of coeff of friction during forming operations. A. D. S.

BITUMEN, ASPHALT, AND TAR

111. Bitumen emulsions. L. C. Bradshaw. *Paint Tech.*, 1960, **24**, 19–23.—Bitumen emulsions of the oil-in-water type are mainly prepared by one of two processes—chemical and mechanical. In chemical emulsions the factors influencing average particle size, such as the alkali concn and the acid value of the bitumen, are discussed. The preparation of chemical emulsions is described, and it is generally found that the chemical method gives a wider scatter of particle size than the mechanical one, although there is little difference in the average particle size obtained. Colloid mills are generally used for making mechanical emulsions. Within certain limits, an increase in the free alkali tends to give emulsions of smaller particle size, to reduce liability to sedimentation, to lower the amount of residual water in the film after the emulsion breaks, and to increase the stability and the action of stone. The stability and visc of the emulsions are discussed, and the means of varying visc, as for example by adding thickeners, are considered. A. D. S.

112. Asphalt producers keep looking for standard quality factor. D. W. Gagle. *Oil Gas J.*, 19.9.60, **58** (38), 121–3.—In an effort to find a quality test for asphalt, a number of methods have been examined and the following observations have been made. The thin film test will correlate with performance behaviour if proper field controls are exercised, and before long will be incorporated into practically all paving asphalt specifications. Kinematic visc studies using the Zeitfuchs cross-arm viscometer have conclusively demonstrated that it is practical to run the entire range of liq asphalt grades at a single temp, 140° F, and it is expected that there will be a general adoption of kinematic limits. In asphalt cement and cutback specifications the temp–visc curve is more than likely to appear. Penetration ratio, obtained by dividing the penetration at 39·2° F, 200 g loading, 60 sec time by that at 77° F, 100 g loading, 5 sec time, and multiplying by 100, seems to give results varying too widely for specification purposes. The Pensky–Martens flash test appears to overcome erroneous fl pt results on asphalts containing anti-foaming materials, but recent work with the Cleveland open cup test, in which standardization is achieved by adding 0·2 ppm of anti-foam agent to the test sample, may stage a comeback. In dist tests for cutback asphalts, foaming of the oil causes variable results—use of 0·2 ppm of anti-foaming agents will permit repeatable and reproducible figures. Use of anti-foam agents improves the curing-index for RC cutbacks, but since they have no effect on the behaviour of the asphalt in the road it may be concluded that these additives are test, not field-service improvers.

Finally, a set of specifications, put forward by West Coast producers and consumers, for paving asphalts is listed.

A. D. S.

SPECIAL HYDROCARBON PRODUCTS

113. Wax technology faces some changes. K. W. Brooks. *Oil Gas J.*, 29.8.60, **58** (35), 89–90.—In the range of *n*-C_{20} through *n*-C_{30} paraffins, the pure *n*-paraffins have the same range of hardness as carnauba wax and are very much harder than commercial grades of paraffin wax. Pure *n*-paraffins also have *ca* 12% higher blocking temp than commercial grades, have a lower coeff of friction, produce a better gloss when slow-cooled in air, and with a 50% chlorine content have a much lighter colour. Addition of polyethylene to *n*-paraffins improves tensile strength to a marked degree and is much greater than the corresponding improvement with commercial waxes. Heat seal properties can be improved by addition of polyethylene resin, the density and concn of the resin being important. The degree of improvement obtained depends, however, on the base wax used.

Specifications for waxes are expected to change, more emphasis being placed on fundamental rather than functional tests. Since wax behaves very much like metals do, it is suggested that metallurgical methods may also prove of value in testing waxes.

A. D. S.

DERIVED CHEMICAL PRODUCTS

114. Recent production and further processing of chemicals from petrochemical raw materials. (In German.) E. Kotter. *Erdöl u. Kohle*, 1959, **12**, 160–6.—III. The diolefins; acetylene and its derivatives.—The basic hydrocarbon and most important representative of the diolefins—hydrocarbons with conjugated double bonds with grouping $>C=C-C=C<$— is 1,3-butadiene as the chief component of synthetic rubber. Raw materials for butadiene production, methods, output, and participating firms are discussed. Sp materials, *e.g.* nylon, are mentioned. Methods for producing C_2H_2 and its derivatives are described, especially by partial combustion of hydrocarbons. 30 refs.

R. T.

115. Synthetic ammonia—nation's No. 1 petrochemical in volume. Anon. *Oil Gas J.*, 5.9.60, **58** (36), 158–60.—Production of synthetic ammonia in the U.S.A. is now approaching 5 million tons/pa. It is made largely from synthesis gas obtained by partial oxidn of oil or steam reforming of natural gas. Six different types of feed, for which seven different process sequences are arranged to produce a specified quantity of anhydrous ammonia, are tabulated. The feeds include by-product hydrogen from electrolytic plant, acetylene-plant tail gas, refinery offgas, natural gas, oil, and natural gas through steam–methane reforming. The production of urea from ammonia is discussed.

A. D. S.

116. From petroleum to plastics. (In French.) M. Moulin. *Chim. et Industr.*, 1960, **84**, 221–40.—French plastics production (1958), 198,000 tons, consumption 222,500, a *per capita* rate *ca* half of the U.S.A. French plants include 13,000 tons/day cat cracking, 14,000 tons/day cat reforming, 1200 tons/day steam cracking. Potential (thousand tons/pa) is: C_2H_4 75 (25 from coal), C_3H_6 130, butenes 10, *iso*butylene 30, butadiene 15, higher olefin/diolefin mixture 30, C_6H_6 7½, $C_6H_5CH_3$ 22, xylenes 17½. Plastics derivable from above listed and production methods outlined. Tabulations given, for main plastics groups (polyethylene, -propylene, -vinyls -styrene, -acrylics, -acetals, -esters, -amides, -carbonates, -urethanes, epoxy resins, phenoplasts, aminoplasts, allyl resins, escorex, buton, durene) indicating raw materials, properties, uses, and in many cases commercial forms (trade names).

V. B.

CORROSION

117. Choice and supervision of materials for apparatus liable to stress cracks with help of indicators. (In German.) E. Rubo. *Erdöl u. Kohle*, 1959, **12**, 247–53. Assumptions, suitability, and possibilities of indicator insertion.—Lab tests are essential for determining the most suitable structural materials for a chem installation which may contain process media liable to cause stress corrosion. An already stressed condition of the stressed surfaces of the structural materials is a contributory factor to the appearance of stress-crack-corrosion. This condition is seldom accurately known. Operating experiences with definite materials make possible a reliable judgment in view of their approval in newly planned installations of other types, only when the intensity of their corrosive media is known. Simple indicators have been developed for numerical evaluation of the intensity degree in the installation. They can be inserted into the installation and, in part, provided externally with remote indicators. Their principle consists of breaking an elec circuit by a rupturing force, which offers advantages in industrial investigations of surface corrosion. The method of indicator introduction for material selection and supervision is described. 12 refs.

R. T.

118. Where to use corrosion probes. Anon. *Oil Gas J.*, 26.9.60, **58** (39), 203–7.—The corrosion probe, which can measure losses as small as a few millionths of an inch, is the most sensitive method in use for detecting and measuring corrosion. Continuous corrosion monitoring is possible because probes can be installed at any point in the unit and measurements can be made without interfering with normal operation. Corrosion-prevention methods can therefore be devised and tested while the unit is still on stream. A number of typical applications, such as the evaluation of materials of construction, corrosivity of new processes, effect of operating changes, stream composition, and corrosion inhibitors, are discussed.

A. D. S.

ENGINES AND AUTOMOTIVE EQUIPMENT

119. Tappet and cam wear. Anon. *Auto. Engr*, 1960, **50**, 351.—This editorial article reviews the causes and possible solutions for the now widespread problem of wear of cams and tappets. Certain oil additives effectively reduce this wear in some instances, but may be quite unsuitable in others. Design and metallurgical factors are equally as important as lubrication, and joint consultation between manufacturers and the oil industry is therefore considered essential for a satisfactory solution to the problem.

D. W. G.

SAFETY PRECAUTIONS

120. Safety in hot tapping pipelines and storage tanks. R. A. Griffith. *Oil Gas J.*, 5.9.60, **58** (36), 183–4.—If, in making connexions to pipelines, it is not practical to remove the pipeline from service, they can be made by hot tapping. Before hot tapping, it is essential to know what fluid is in the line and whether the line is in high or low pressure service. The procedure for hot tapping is outlined and is extended to tank shells, where it is necessary that the fluid level should be at least 7–14 ft above the welding location. Welding methods are considered and, where hot taps are necessary near the fluid level, a method is outlined.

A. D. S.

121. Science of fire protection. "High-risk" practice and precautions. R. Yule. *Times Rev. Ind.*, 1960, **14** (165), 12, 15.—General discussion of fire hazards of petrochem plants and description of precautions at Shell Chemicals Carrington 850-acre (300 occupied) works. 22 full-time firemen, 40–50 part-time. General purpose tender, two foam tenders (all-purpose foam applicable at $\leqslant 1$ gal/min/ft² liq surface), three trailer pumps, emergency jeep, two mobile dry powder outfits. Fire main pressurizable to 150 psi, 20 tons/min (from Mersey); 250 ground hydrants, 1500 portable extinguishers.

V. B.

ECONOMICS AND MARKETING

122. World petroleum statistics—1959. Anon. *Inst. Petrol. Rev.*, 1960, **14**, 324–8.—World production of crude petroleum totalled 6074 million brl in 1959, which was 7% higher than in 1958. World imports totalled 6074 million brl in 1959, a rise of some 8% over 1958. Imports of refined products in the world during 1959 were 1133 million brl, and exports and re-exports 1247 million. It is suggested that world import total is understated and may therefore be *ca* 1324 million brl. Output of refined products totalled 6303 million brl, an increase of *ca* 5% compared with 1958. The area with the largest rise was the Middle East with 14%, followed by the Far East with 7%. Most of the increase in product output was dist fuel oil, which rose by 7%, and residual fuel oil, which rose 3%. Tables are presented showing world supply and demand for crude petroleum and refined products, world output for refined products, and domestic demand for refined products by countries.

A. D. S.

123. World tanker statistics second quarter 1960. Anon. *Inst. Petrol. Rev.*, 1960, **14**, 310–11.—Oil tankers under construction in the world during the second quarter of 1960 totalled 243 ships of 4,358,613 gross tons. This was a drop of 293,547 tons compared with the previous quarter, and represented 47·8% of the total tonnage of all types of vessel under construction. Britain maintained its position as the leading nation of tanker registrations with Liberia second and Norway third. Sweden has taken second place to Britain in the list of countries with tankers under construction. Tabulated details are given of registrations, tankers under construction, and tankers launched during this period.

A. D. S.

124. Application of exploration and production cost trends to determination of fair-market gas prices. W. S. Eggleston. *J. Petrol. Tech.*, June 1960, **12** (6), 11–14.—It is impossible to allocate costs between oil and gas on a realistic basis.

Over a period of six to ten years representative oil companies distributed exploration expenses as follows: 18% exploration department management expense; 8% rentals in lieu of drilling; 22% land acquisition; 15% geophysics; 37% exploratory drilling. Exploration costs rose by *ca* 175% in ten years from 1948. Production costs have been allocated as follows: development 47%; production operating 29%; property taxes 13%; departmental management expense 3%; cost depletion 8%. A weighted average increase of 80% is indicated for production costs.

Many companies over a period have put 30% of their annual cash outlay into exploration, and 70% into development and production. Thus there has been 108% increase in the joint costs.

To establish a fair market price before 1954 it is necessary to establish that certain conditions held: (1) arm's length bargaining; (2) relatively free economy; (3) comparatively narrow price range limits; (4) fair and reasonable for the time and conditions. In these terms 8·5 c/Mcf was a fair and reasonable field price for gas in S Louisiana in 1948 (range 7·5–9·5 c). In 1957 the figure should be 17·7 c/Mcf; in 1959 21 c/Mcf. 243 contracts negotiated in S Louisiana for 1952–58 gave prices agreeing closely with the above trend. An escalation rate of 1 c/Mcf pa should currently be considered a minimum.

G. D. H.

MISCELLANEOUS

125. Investment evaluation by present value profile. L. D. Wooddy and T. D. Capshaw. *J. Petrol. Tech.*, June 1960, **12** (6), 15–18.—It has been estimated that in 1959 $\$7 \times 10^9$ was invested in the U.S.A. oil industry, $\$4{\cdot}5 \times 10^9$ being in the drilling and producing side. Because of financial and tax angles the evaluation of a proposed investment may have to be made assuming several different ways of financing. A realistic cash flow stream resulting from the engineering analysis is possible only by the use of proper product prices and operating costs over the period involved. Payout time and profit-to-investment ratio are yardsticks which may lead to questionable investment decisions because

they ignore the time value of money. Present-value profit and discounted-cash-flow rate of return are better but not perfect.

The use of different procedures may lead to different conclusions about the same project. The choice of a safe interest rate raises problems.

Some difficulties in the rates of return method have been attributed to the implicit assumption that funds generated by a project will be re-invested at the project rate. Plotting of present-value profit *v.* discount rate may remove some confusion. The actual value of the profit is given at the zero discount line; the discounted-cash-flow rate of return is the intersection of the profile with the zero profit line.

Examples of the use of the profile are given, including application to pressure maintenance and to choice of spacing.

G. D. H.

BOOK REVIEWS

Sahara. Georg Gerster. London: Barrie and Rockliff, 1960. Pp. viii + 302. 30*s*.

The first half of the book is a disjointed history of exploration of the natural resources and rock pictures in this vast remote desert during the past hundred years by explorers and travellers, priests and missionaries, soldiers and airmen, geologists and archæologists, water and mining engineers, until the discovery of oil in 1956. Most of these were French, including some women, and their splendid achievements deserve a better chronicler. The flap says that "The Swiss journalist and traveller, Georg Gerster, on his last trip to the Sahara covered some 7500 miles," but this is not difficult over an area 1000 miles long and 500 miles wide dotted with airstrips. Inside the covers are two coloured maps, one topographical, showing oases and forts, and one political, showing the new oilfields and communications. There is a glossary of Arabic words (giving the correct pronunciation as Sâhara meaning dun-coloured), a bibliography, and a ten-page index.

The English translation (from the German) is colloquial and verbose to the point of irritation. Sahara oil occupies only one chapter of 50 pages, less than one-fifth of the book, but nearly half the photographs. It begins on page 164 and is typical of the writing; only readers who know the story will be able to piece it together.

> "11. BLACK GOLD
>
> "The barrel of the sub-machine gun chafed my knees till they were sore. Every time we hit a pothole it bounced up between my legs and clattered back on the floor of the car. The sun had gone down behind the dunes like an enormous fried egg. From time to time a jerboa was caught in the glare of the headlamps and eyed us, motionless. We had lost our way several times. Mustafa was on edge. Whenever lights appeared at the edge of the track, he slowed down nervously, glancing at me to make sure I had the gun at the ready and my finger on the safety-catch."

On the next page:

> "I know no other landscape which so perfectly combines freedom and order. Countless billions of grains of sand, swept together in great depressions by capricious winds, have fallen into layers with mathematical accuracy. The natives, whose vocabulary contains two thousand words for a camel and two hundred for a date, have twenty different ways of describing the shape of the dunes."

P. 196:

> ". . . women have not been allowed into Hassi Messaoud, even on a visit."

This reviewer flew there with the CFP's Social Assistant, Madame Orfila, on one of her regular visits last November.

P. 210:

> "The workers at Edjeleh drink twenty to twenty-five pints of liquid a day, the maximum the human body can absorb in twenty-four hours, and after six weeks in this inferno, their lips cracked, their mucous membranes dried up, their muscles aching, and their eyes red and inflamed, they fly home to France to recover."

The heat and dust here are no worse than in parts of Persia and Iraq, where oil wives as well as husbands lived through the summers before the use of aeroplanes or air conditioning.

On p. 206 the author pours scorn on "Hallis D. Heldburg" (Hollis D. Hedburg) of the Gulf Oil.

Technical terms concerning oil are misused; p. 170 "The *refractory* method (also on p. 165) of seismic explosions also failed. On the other hand, the refraction method . . . was responsible . . ."

"In the Edjeleh oilfield the Schlumberger process was employed." Its logs are made in almost all wildcat and development wells.

The last four chapters, characteristically entitled "Boom in the Oases," "Schools for Nomads," "Cement of Eurafrica?," "Taming of the Shrew," covering the possible consequences of the discovery of copious supplies of oil and artesian water, draw attention to one of the finest things about the Sahara, namely, the dedication of young Frenchmen to its scientific and social problems.

F. E. W.

Corrosion Problems of the Petroleum Industry. London: Society of Chemical Industry, 1960. Pp. 235. 30*s*.

In November 1959 a symposium on this subject was held jointly by the Institute of Petroleum, the Corrosion Group, and the Chemical Engineering Group of the Society of Chemical Industry. Nine papers were presented and covered aspects of the industry from production and gathering equipment, marine structures, tankers, storage tanks, pipelines, and refinery equipment. The question of testing and the use of corrosion-resistant materials was also discussed. The full report of the congress and of the discussions which followed the reading of the papers are now brought together in one volume, which should prove of considerable value to anyone who has to deal with combating of corrosion.

Gas Chromatography Abstracts, 1959. Ed. C. E. H. Knapman and C. G. Scott. London: Butterworths Scientific Publications, 1960. Pp. 164 + x. 42*s*. Postage 1*s*. 6*d*.

This volume contains over 700 abstracts of articles published during 1959 on the subject of gas chromatography. It is the first volume of abstracts to be published by the abstracting service organized by the Gas Chromatography

Abstracts Editorial Committee, and is a continuation of the work previously published in a similar volume for 1958.

In addition to the abstracts, a full author index is given, together with a detailed subject index.

Tables for Petroleum Gas/Oxygen Flames. I. I. Berenblut and Anne B. Downes. London: Oxford University Press, 1960. Pp. 107. 30*s*.

Theoretical equilibrium compositions and thermodynamic properties of the combustion products from a mixture of rich LPG/oxygen flames are given in a series of tables, the calculations for which take into account dissociation of the gases into all possible components. Values are given for the following mixtures: propane, propane/propylene, propylene, propane/butane, butane, butane/butylene, and butylene. Tables of adiabatic flame temperatures and of the composition of combustion products of propane/oxygen flames are also included.

The Uses of Electricity in the Oil Industry. Ed. E. A. Reeves. London: Ernest Benn Ltd. Pp. 296. 50*s*.

During the past two years a series of interesting articles have appeared in the *Electrical Journal*, each article covering some aspect of the use of electricity in the oil industry. This collection of 21 articles has now been published in book form and fulfils a long-felt want in this particular field. Although it is possible that some of the information has been superseded by more up-to-date applications, the book should be of great assistance to those who are engaged in the planning and operation of electrical equipment.

Wachs-Enzyklopädie. Vol. II, Pt 1. L. Ivanovszky. Augsburg: Verlag für Chemische Industrie H. Ziolkowsky K.G., 1960. DM. 33. Pp. 486.

Vol. I of Dr Ivanovszky's "Wachs-Enzyklopädie" was published in 1954 and dealt with the properties of waxes. In all, four volumes are planned, and of these the second volume will be in three parts, which will cover the analysis and testing of waxes and similar materials. The first part of Vol. II has recently appeared and contains much introductory material on the methods of wax investigation. Following a general discussion of wax testing, the available methods are classified and a plan of investigation outlined. A comprehensive and indexed list of the standards issued by the various European and American organizations concerned with waxes occupies about 45 pages and forms a most useful reference. The rest of the volume will be devoted to detailed descriptions and discussion of methods of investigation in current use, and these are divided into sections dealing with sampling, thermal properties, mechanical, optical, and electrical properties, solubility, colloid properties, retention, molecular weight, and structure. Pt 1 covers only the sampling, thermal, and mechanical aspects, and the remaining subjects will be discussed in Pts 2 and 3.

The work is planned on a very comprehensive scheme. Vol. I occupies 232 pages and the first part of Vol. II 486 pages. Presumably Pts 2 and 3 will be of similar size. Vols. III and IV, on the preparation of waxes and the properties and applications respectively, are to appear later, and will doubtless contain a wealth of material. The value of a reference work such as this depends so much on its completeness that it is greatly to be hoped that the intervals of publication can be reduced, particularly as regards the remaining parts of Vol. II. If this can be done the "Enzyklopädie" will certainly become a standard work of reference for a long period. In this connexion the importance of indexing cannot be over-emphasized. The subject index of Vol. II, Pt 1, is good, but the author index on p. 485 does not seem entirely adequate considering the amount of original literature on the subject.

E. B. E.

Review of Benzole Technology 1959. National Benzole and Allied Products Association. London: The Association, 1960. Pp. 151. 22*s*. 6*d*., post free.

Seventh in the annual reviews of benzole technology issued by the NBA, the present volume follows the general lines of its predecessors with one important change. This change is the allocation of a larger proportion of the book to the industrial uses of benzole. Thus, care is taken of the increased use of benzole products as raw materials for the chemical industry. The section covers solvents; the use of benzene for the production of polymers, phenol, agricultural chemicals, and detergents; toluene for polymers and other uses; xylenes; sulphur compounds; and other crude benzole constituents.

References to literature number 1272, and the usual sources of information have been supplemented by the Information Bulletin of the Coal Tar Research Association.

Symposium on Air Pollution Control. American Society for Testing Materials. Philadelphia, Pa: The Society, 1960. Pp. 44 + iv. $1.50.

The report of a symposium held by ASTM Committee D-22. The subjects discussed in the five papers were, first, the meteorology of the Pacific Coast and wind movements and temperature inversions responsible for accumulation of pollutants. Atmospheric analysis was the general subject of three of the papers, which dealt with fluorescent dyes as airborne tracers, the determination of formaldehyde and methanol, and the separation of gaseous and particulate fluorides.

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OILFIELD EXPLORATION AND EXPLOITATION

GEOLOGY

126. Possible uses of clay minerals in search for oil. C. E. Weaver. *Bull. Amer. Ass. Petrol. Geol.*, 1960, **44**, 1505–18.—This paper was written to illustrate the wide varieties of geologic information that can be obtained from the clay minerals.

In the Upper Mississippian and Lower Pennsylvanian of the Mid-Continent the clay suites reflect the source areas and tectonic history. Both in recent and ancient sediments clay mineral suites are related to depositional environments. The available data suggest that there may be some relation between hydrocarbon production and expanded clay minerals. Expanded clays retain their pore water to greater depths of burial than do the other clays. If hydrocarbons are formed at any appreciable depth the shales containing expanded clays would be the main source of water to carry the hydrocarbons from the shales. E. N. T.

127. Petroleum resources in basement rocks. K. K. Landes *et al. Bull. Amer. Ass. Petrol. Geol.*, 1960, **44**, 1682–91.—Commercial oil deposits have so far produced *ca* 100 million brl of oil from basement rocks in Kansas, California, Venezuela, and Morocco; most of these deposits have been found largely by accident.

The thesis of this paper is that such accumulations are not freaks, but are normal concn of hydrocarbons, obeying all the rules of origin, migration, and entrapment. The four essentials for an oil pool, namely, source, reservoir rocks, seal, and trap, are present in all of the basement rock fields so far discovered. Presumably there are infinitely more places yet to be discovered where these same conditions exist. E. N. T.

128. Will computers click as oil finders? G. T. Kinny. *Oil Gas J.*, 10.10.60, **58** (41), 110–11.—Several companies are studying the application of machine data processing for evaluating oil prospects. Geological data can be coded and recorded on

cards. In some cases rocks can be identified by machine, and many draughting operations can be done mechanically. Classification of coded data can be carried out automatically, leaving the geologist free for interpretation and planning. It is suggested that the computer system could advance the knowledge of petroleum geology by 20 years in one leap. J. C. M. T.

129. Cretaceous sedimentation in Upper Mississippi embayment. W. A. Pryor. *Bull. Amer. Ass. Petrol. Geol.*, 1960, **44**, 1473–504.—The purpose of this paper is to depict the gross geometry, determine the patterns of sedimentation and depositional environments, show relations of sediment transport to depositional strike, determine the provenance, and interpret the geologic history of the late Cretaceous Upper Mississippi embayment.

The late Cretaceous (Gulfian) sediments were chosen for this investigation because their present limits apparently differ little from the original depositional extent; they exhibit a wide range of lithic types over relatively short distances; they are well exposed; and subsurface control is available. Three major environments of deposition are represented by these sediments: (1) the fluviatile and upper deltaic environment; (2) the pro-delta shelf environment; and (3) the transitional delta platform environment, all of which are fully dealt with herein. E. N. T.

130. Geology of Pennsylvanian gas in Four Corners region. M. D. Picard *et al.* *Bull. Amer. Ass. Petrol. Geol.*, 1960, **44**, 1541–69.—Accumulations of Pennsylvanian gas and casinghead gas in the Four Corners region occur in carbonates of Desmoinesian age in four lithologic zones of the Paradox member of the Hermosa formation. 11 gas and five casinghead gas fields have been found, but these are still largely undeveloped with respect to gas.

These Pennsylvanian gas accumulations seem to be essentially *in situ* occurrences. The source beds are believed to be present in each zone; migration was predominantly local, not exceeding a few miles; and entrapment occurred in laterally adjacent areas of bioclastics and sparsely to moderately fossiliferous carbonates. E. N. T.

131. Permian stratigraphy at Carlin Canyon, Nevada. T. G. Fails. *Bull. Amer. Ass. Petrol. Geol.*, 1960, **44**, 1692–703.—Three wholly Permian formations occurring stratigraphically between the Pennsylvanian–Permian Strathearn formation and the Tertiary Humboldt formation at Carlin Canyon are defined herein. All three are predominantly calcareous. Names proposed for the three formations, in ascending order, are: Buckskin Mountain, Beacon Flat, and Carlin Canyon.

The upper and lower units have high quartz-silt content and the middle unit is grey, relatively clean calcarenite with abundant fusulinids. The Buckskin Mountain formation is believed to be wholly Wolfcampian in age, the Beacon Flat to be Wolfcampian and Leonardian, and the Carlin Canyon formation to be Leonardian and Guadalupian. E. N. T.

132. Las Animas arch—promising oil and gas frontier. J. A. Kornfeld. *World Oil*, Sept 1960, **151** (4), 87.—There is active exploration along the Las Animas arch in E Colorado and W Kansas, where there have recently been some significant discoveries in an area which has been drilled sporadically for 30 years. A series of deep tests has provided much useful subsurface data, and regional cross-sections indicate important areas of truncation and overlap, as well as indicating structural conditions.

Regional structure and stratigraphy are briefly outlined: beds range from pre-Cambrian to Permian, and there are potential reservoirs in Cambro-Ordovician, Mississippian, and Pennsylvanian rocks. The Cambro-Ordovician and Mississippian have not yet been proved productive, but some limestones show staining. The Pennsylvanian produces from sandstones and limestones in several areas. C. A. F.

133. Wyoming hit snaps Wind River lull. J. C. McCaslin. *Oil Gas J.*, 10.10.60, **58** (41), 285.—An important discovery has been made in Natrona County, Wyoming, where 1 Wallace Creek flowed 1416 bd from the Upper Cretaceous Muddy zone at *ca* 10,000 ft. The well is in the SE Wind River Basin, where discoveries are rare: nearest production is 8½ miles N at Cooper Reservoir, and there are signs of a NW–SE trend of production through Wallace Creek. This follows the SE limits of the basin, unlike most trends in the area, which do not follow the basin margins. There have also been recent finds in the Lost Cabin and Lysite areas. Much of the basin remains untested, and future prospects are good. C. A. F.

134. Facies analysis of Upper Devonian Wabamun group in West-Central Alberta, Canada. J. M. Andrichuk. *Bull. Amer. Ass. Petrol. Geol.*, 1960, **44**, 1651–81.—The Wabamun group and equivalent Palliser formation are generally considered to be Late Devonian in age. The group exhibits three major facies, namely, limestone at the NW, anhydrite and dolomite at the S and SE, and dolomite in the intermediate areas.

Petroleum has accumulated in two main types of stratigraphically controlled traps within the Wabamun group. Facies change from porous secondary dolomites to relatively non-permeable equivalents approx up regional dip (mainly eastward) is responsible for gas entrapment in the Okotoks–East Calgary–Olds trend of fields. In the Edmonton area oil or gas has been localized in erosional hills made up of porous Wabamun dolomites at the pre-Cretaceous unconformity. E. N. T.

135. Oil and gas exploration techniques in Northern Yukon and Northwest Territories. W. G. Campbell. *Oil in Canada*, 25.7.60, **12** (39), 42–4.—The topography of the area and difficulties of transport are briefly outlined. International Harvester TD–24 drawing sledges were used for transporting 2600 tons of equipment. Rigs and heavy plant were supported on piles for which holes were drilled with air. Permafrost presented no special drilling difficulties. Work can progress through ten months in the year. G. B.

136. Stratigraphy of coastal range in Tarapaca Province, Chile. G. O. Cecioni and F. Garcia. *Bull. Amer. Ass. Petrol. Geol.*, 1960, **44**, 1609–20.—The main objective of this study is to present the stratigraphy of the Chilean Coastal Range between Iquique and Arica. Strata range in age from Bajocian to Oxfordian, but no ammonites of definite Bathonian age have been found. Three morphological units are exposed between Iquique and Arica—they are, from W to E, the Pampa, coastal range, and the Andean range.

The Jurassic sediments are folded into a general N trend, whereas the Cretaceous sediments have a general E strike. Between the Upper Oxfordian and the basal Cretaceous there is evidence of a major orogeny, which by definition is Nevadian. The Andean diorite was locally intruded after the Nevadian orogeny, and was subsequently eroded, supplying the pebbles of the Cretaceous basal conglomerates. E. N. T.

137. Geologic history of Red Sea area. D. H. Swartz and D. D. Arden, Jr. *Bull. Amer. Ass. Petrol. Geol.*, 1960, **44**, 1621–37.—The purpose of this paper is to examine the Red Sea tectonics in relation to the regional setting, to point out the facts that must be taken into account in any explanation of its origin, and, finally, to present a summary of the geologic history of the Red Sea. The Red Sea depression has been considered by previous workers to be (1) a graben, with down-dropped centre block resulting from compressive forces, or (2) a paar, or depression caused by the moving apart of

two crustal blocks, and thus essentially a tensional feature. It is to the second hypothesis that the present writers subscribe.

During the Mesozoic the most important movements were epeirogenic; faulting and volcanism occurred in the Jurassic and Cretaceous. Beginning in the lower Miocene, the " Horn of Africa " began to separate from the Arabian Peninsula. This separation became complete as the Arabian block moved towards the Tethys geosyncline, and during the Pliocene the Red Sea and Gulf of Aden were joined. E. N. T.

138. Oil interest flares throughout Africa as strikes open new areas. J. C. McCaslin. *Oil Gas J.*, 10.10.60, **58** (41), 286.—There have recently been very important discoveries in Africa, particularly during the past 18 months. In Libya a number of major producers have been completed, such as 2 Hofna, 360 miles SE of Tripoli, which flowed 1500 bd of 43° oil, and Oasis F–9, which flowed 11,500 bd. Details of other discoveries are given. Exploration and development activities are also reviewed for Algeria, Angola, Cameroons, Egypt, Gabon, Nigeria, Senegal, and the Spanish Sahara.

Africa is mainly underlain by basement rocks, but there are bordering geosynclinal areas, highly folded and faulted in places. In the N the Atlas belt is filled with thick Mesozoic and Tertiary sediments where the main discoveries have been made. Future prospects of the continent are excellent.
C. A. F.

139. Mechanism of salt migration in Northern Germany. F. Trusheim. *Bull. Amer. Ass. Petrol. Geol.*, 1960, **44**, 1519–40.—For the last 50 years, N Germany has been considered the type example of geodynamic salt structures; the majority of the structures can be directly or indirectly attributed to " halokinesis," a term proposed to designate all processes connected causally with the autonomous, isostatic movement of salt.

These N German Permian salt structures are classified into salt pillows, salt stocks, salt walls, and extrusions along fissures. They are accompanied by primary, secondary, and third-order peripheral sinks. The halokinetic movements have taken place in an essentially continuous and autonomous fashion from the Triassic to the present day. E. N. T.

140. Surani, Rumania, anticline with two erosion-depleted, non-contemporaneous oil reservoirs. R. P. Walters. *Bull. Amer. Ass. Petrol. Geol.*, 1960, **44**, 1638–50.—The Surani area is in the foothill belt of the S Rumanian Carpathian Mountains. It has two formations exposed with sands containing a residue of oil—Meotic of the Pliocene and Kliwa of the Oligocene. These represent oil reservoirs which have been depleted by erosion; the oil sands of the upper reservoir bear a normal relation with the anticline, but those of the lower do not.

The conclusions reached are that the Oligocene reservoir was depleted long before the Pliocene was deposited, and that it was formed on some feature other than the Surani anticline on which the depleted reservoir is now found. E. N. T.

GEOPHYSICS AND GEOCHEMICAL PROSPECTING

141. Graphical method of analysing velocity logs. C. R. Davis. *Oil Gas J.*, 3.10.60, **58** (40), 79–89.—A method is described for determining formation porosity and saturation from sonic logs without using assumed values of matrix velocity. A horizon in the same formation is selected which is known to have 100% water saturation, and values of conductivity squared are plotted against transit time. This is a linear relationship, and by extrapolation to the abscissa gives the reciprocal of the matrix velocity. Knowing the matrix velocity, the abscissa can be calibrated in terms of porosity if desired. On plotting data from horizons of unknown porosity and fluid saturation on the same chart, points falling well below the line can be assumed to have some oil saturation. Six field examples are discussed. J. C. M. T.

DRILLING

142. Current oil industry fishing techniques and tools. Pt 2. Open hole. W. Medders and D. U. Skinner. *World Oil*, Sept 1960, **151** (4), 59.—Modern techniques for open hole fishing in drilling operations are described in detail. Operations include: (1) recovery of drill pipe; (2) recovery of drill collars (two methods); (3) recovery of twist-off drill pipe; (4) recovery of small objects; and (5) recovery of miscellaneous wire-line tools. Diagrams and methods show equipment and methods used for each of these. C. A. F.

143. Modern well-completion series. 8A. Formation testing fundamentals. C. R. Richardson. *Petrol. Engr*, Aug 1960, **32** (9), B36.—Formation testing is defined as a method for obtaining data on the producing potential of a formation by removing the hydrostatic head of the drilling fluid. The development of testing procedures over the past 35 years or so is outlined; present techniques are detailed. The design and operation of the various items of equipment required are made clear by a description and numerous drawings.
G. D. F.

144. Rotary drilling in low pressure loss formations. 2. Determining pressure values and reducing mud loss. K. Hartland. *Petroleum, Lond.*, 1960, **23**, 333.—In this part, methods are outlined for determining pressure changes caused by pipe movement. It is stressed that pressure waves are of great importance. Finally, methods of reducing mud loss, by decreasing the permeability of thief sections, by reducing formation pressure, and by various other methods are given.
G. D. F.

145. Underwater completion looks economical. Anon. *Oil Gas J.*, 3.10.60, **58** (40), 65.—The discovery well Humbold 3–3, located 6200 ft offshore in 132 ft of water off the N coast of Peru, was drilled from a floating barge and completed under water. All well-head fittings are on the sea floor, and flow is controlled from the shore by means of a hydraulic valve on the well-head. An aluminium flow line is used. The well tested 480 bd of 36·5° gravity crude from *ca* 1000 ft.
J. C. M. T.

146. High pressure completions. W. D. Smith, Jr. *Drilling*, Oct 1960, **21** (13), 62.—In S Louisiana gas wells have bottom hole pressures from 8700 to 13,000 psi, together with corrosive conditions. If corrosion or mechanical failure cause leakage from the tubing to the annulus it is very difficult to kill the well. This has been overcome by installing a 1¼-inch tubing string inside a 2⅞-inch tubing string. Production is through the 1¼-inch string, and any failure leaves the 2⅞-inch string still in charge of the situation. The space between the two strings is filled with corrosion inhibited fluid. Further precautions include pulling and renewing the 7-inch casing on completion in case of wear during drilling. J. C. M. T.

147. Aluminium drill pipe used on Texas well. Anon. *Oil Gas J.*, 17.10.60, **58** (42), 72.—A 10,400-ft well was drilled in De Witt County, Texas, with a 7000-ft rig, using 4½-inch aluminium drill pipe with shrunk-on steel joints. Wt of the aluminium pipe is *ca* half that of steel, approx doubling the depth capacity of drilling rigs using it. Fatigue endurance has been tested at 800,000–1,500,000 cycles compared with 500,000–800,000 for grade E steel pipe under the same load conditions. J. C. M. T.

148. The tubing string: growing factor in deep well design. W. J. Safford. *Drilling*, Oct 1960, **21** (13), 65.—Deeper wells

and more severe pressure conditions have brought about the use of high yield strength tubing, but increasing the yield strength of steels decreases the ductility, makes them more notch-sensitive, more susceptible to corrosion, erosion, stress corrosion cracking, and hydrogen embrittlement. Care should be used to avoid slip and tong marks on high duty pipe. Alloys and heat treatments suitable for conditions in one area may be quite unsuitable in another, and in some cases it may be better to increase wall thickness than to increase yield strength. J. C. M. T.

149. Hydraulic wall-anchored drill collar promises lower drilling costs. J. M. Kellner and A. P. Roberts. *Oil Gas J.*, 3.10.60, **58** (40), 87–9.—A new type of drill collar uses the pressure drop across a jet bit to apply load on the bit, instead of dead wt. The upward thrust which results from this is transmitted to the walls of the hole by diaphragm-type pressure-actuated anchor shoes. The prototype is designed for 6¾-inch hole, measures 6 inches od × 37 ft long and weighs *ca* 2200 lb. A force of 40,000 lb is exerted on the bit with a pressure drop of 1000 psi across the bit. Re-setting is required every 2 ft drilled, but is rapid. Advantage of the new tool over ordinary drill collars are ability to apply high bit wt at shallow depths, less handling time, less hoisting power required, and lower first cost. J. C. M. T.

PRODUCTION

150. How to design a closed rotative gas lift system. Pt 2. Sample calculations. H. W. Winkler. *World Oil*, 1.8.60, **151** (2), 103.—Examples of calc are given for designing closed rotative gas lift systems for intermittent wells. In the case of a single well it is necessary to estimate: (1) daily injection gas requirement; (2) approx compressor brake hp; (3) design of high pressure injection gas system; (4) excess or make-up gas vol; and (5) design of low pressure gas gathering system. Sample calc for each of these is given, and the effect of additional wells in the system is described. A detailed flow diagram of a closed rotative gas lift system for multi-well installation is given. It is concluded that small closed rotative gas lift systems with intermittent wells require proportionally larger low pressure gas gathering and high pressure injection gas systems than large systems, when time cycle surface controllers are used. In small closed systems central programmers should be considered. C. A. F.

151. Simultaneous underground gas storage and secondary oil recovery. W. F. Burke. *J. Petrol. Tech.*, July 1960, **12** (7), 22–6.—If underground storage for gas companies can be combined with secondary oil and/or gas recovery, liq hydrocarbon recoveries can greatly reduce the overall cost of storage. In the Dallas–Fort Worth area particularly, studies showed gas was available in excess of load requirements for some 200 days/year. Deep reservoirs seemed best, for a desirable delivery rate is over four times the desirable input rates, and these were available in the Dallas–Fort Worth area. The New York City (Mississippian) limestone field in Clay County, Texas, was near a large dia pipeline. In 1952 a 585-acre storage unit was formed, and the wells were redrilled and recompleted, gas injection beginning in 1953. The depth is 6100 ft, and the field has given 825,000 brl of crude and 3740 MMcf of gas from ten wells. The initial stock-tank oil was estimated to be $5{\cdot}8 \times 10^6$ brl, its formation vol factor being 1·66. It was thought that *ca* 6×10^9 cu ft of gas could be stored at 3200 psig, some of the gas going into solution. Two injection and four withdrawal wells were used. The 2640-hp compressor station could handle 17·4 MMcf/day at 3200 psig discharge. 24×10^9 cu ft of gas have been cycled in four full storage cycles, and to Jan 1960 406,171 brl of oil had been produced. The capacity of the withdrawal wells is 22 MMcf/day, and output can be supplemented by the two injection wells. Cycling of gas when the reservoir is highly charged and withdrawals are low is the means of recovering liq. Comparable operations are proceeding in the Ambassador field in Clay County, six miles to the NW. G. D. H.

152. Laboratory studies of a pulsed neutron-source technique in well logging. J. Tittman and W. B. Nelligan. *J. Petrol. Tech.*, July 1960, **12** (7), 63–6.—Scintillation detectors give voltage pulses of heights related to the energies of the initiating γ-rays, and hence can give information on the nature of the elements in the rocks. Accelerator-type neutron sources can be pulsed and offer other advantages over encapsulated chemical-mixture sources in logging.

The cyl neutron generator tube accelerates deuterons which bombard a tritium target, giving large numbers of 14-Mev neutrons. Continuous and pulsed neutron yields have been produced under simulated field conditions. Pulses of 500–5000/sec are adequate. Most attention has been given to pulses longer than *ca* 10 microsec. Neutrons produce γ-rays by inelastic collisions with nuclei and by thermal capture. Inelastic collisions occur only soon after emission of the neutrons, and the γ-rays are dependent on the struck nuclei and the energy of the neutrons. Thermal captive gives different γ-rays, dependent on the compound nucleus. Slowing down to thermal velocities requires *ca* 10 microsec in water; after about 200 microsec capture-γ-ray production will almost cease. The inelastic collision γ-rays can be recorded by switching on the scintillation counter for a short time coincident with the neutron pulse; delayed switching on records capture γ-rays. Despite smearing, these steps allow C and O to be separated from H, Si, and Cl.

Lab tests indicate that comparison of the thermal inelastic spectra permits the obtaining of data which would be difficult to derive from the dc spectra. G. D. H.

153. Field histories show benefits of gas and water injection projects in Eastern Venezuela. L. A. Ramsey. *J. Petrol. Tech.*, July 1960, **12** (7), 33–6.—The L 1 sand of the OG-56 reservoir is a channel sand, with 300 mD permeability in the poorly sorted silty sandstone and 8D in the coarse well-sorted standstone. Saturation methods indicated $125{\cdot}3 \times 10^6$ brl of oil in place, and material balance gave 133×10^6 brl. The original gas cap was 11·1% of the pore vol; initial pressure was 1910 psi and solution GOR was 660 cu ft/brl. Solution gas drive and gravity segregation dominated production in the pressure-depletion phase of production. When 32×10^6 brl of oil had been produced the pressure was 1060 psi, 30 wells were on artificial lift and 14 were flowing, the production being 8650 bd. Injection of 9 MMcf/day began, and was raised to 14 MMcf/day using five up-dip wells. Within nine months serious gas channelling began in one sector. Reduced producing rates and water injection checked this. Down-dip outlets gave ten times the recovery of up-dip wells. By the end of Aug 1959 $53{\cdot}8 \times 10^6$ brl of oil had been recovered, and this was $6{\cdot}3 \times 10^6$ brl more than calculated for natural depletion. At abandonment 39% of the reservoir pore space is expected to be occupied by gas, and this will be removed at constant pressure by injecting fresh water down dip, with good prospects of further oil recovery.

The G sand, OG-271 reservoir, is a channel sand with permeabilities of 5–20D, and had 26,966,000 brl of oil initially, the solution GOR being 565 cu ft/brl. Originally the pressure was 1930 psi and had fallen 730 psi in producing 6,031,000 brl of oil. Some water advance was noted. Water injection began in 1954 at 4000 bd, rising to 5200 bd, and the pressure has risen to 1450 psi. Reduced GOR were noted in six months, and $9{\cdot}9 \times 10^6$ brl of oil is expected to be recovered, compared with $9{\cdot}2 \times 10^6$ brl by natural depletion. G. D. H.

154. Operation of a dry-desiccant type hydrocarbon recovery unit. Q. S. Drake and E. R. Dawson. *J. Petrol. Tech.*, July 1960, **12** (7), 19–21.—After passage through conventional high-pressure separators, gas enters the skid-mounted recovery unit, passing alternately through two silica-gel packed vertical adsorption towers, and thence to the gas sales line. Heated regeneration gas is used to remove the adsorbed liq, which are condensed in heat exchangers and stabilized.

A unit for five dist wells was able to dehydrate 25 MMcf/day to less than 7 lb/MMcf, and recovered 50 bd of stable hydrocarbons, recovering at least 75% of pentanes and heavier. The effectiveness of the silica-gel did not seem to have changed during one and a half years. The desiccant cost $3000.

The unit is automatic, and requires *ca* 30 minutes/day of switcher time, mainly for inspection and to change charts. Heater coils, the gas drive pump, and diaphragm-operated valves have given troubles which have been largely overcome. The cost of the unit was $57,000, installation adding $18,000.

A glycol-type dehydrator would have cost $25,000, 16,113 brl of dist was recovered from $7{\cdot}4 \times 10^9$ cu ft of gas. Maintenance cost was $672 in 1959. G. D. H.

155. Outlook for Louisiana's offshore production. S. V. McCollum. *J. Petrol. Tech.*, July 1960, **12** (7), 28.—From 1947 to early 1953 there was no leasing; then *ca* ten rigs were operating until mid-1956. A U.S. supreme court injunction shut down activity. When the dispute was settled over 100 rigs were in use until a recession set in. By April 1960 there were 1799 oil wells, 418 gas wells, and 874 dry holes. Production of oil and condensate was 226,000 bd; gas output was 909 MMcf/day. 3,375,000 acres are now under lease; the cumulative investment is $616,266,000. At the last offshore sale 454,046 acres fetched $246,379,283. Total offshore investment is $\$3 \times 10^9$; revenue is estimated to exceed operating expenses by $\$6 \times 10^8$. Current expenditure is $\$25 \times 10^7$/pa (excluding lease purchases) and income is $\$2 \times 10^8$/pa.

Nearly half the gas fields have less than 1×10^{11} cu ft each; over a third are not connected to pipelines. For the larger fields there may be four years between leasing and starting gas sales. Drilling costs for a mobile barge may be $12,000/day. For a 12,000-ft well the oil allowable may be 185 bd; hence multiple completions are necessary economically. G. D. H.

156. Equilibrium in the methane–carbon dioxide–hydrogen sulphide–sulphur system. H. T. Kennedy and D. R. Wieland. *J. Petrol. Tech.*, July 1960, **12** (7) AIMME Tech. Paper No. 8120, 166–9.—Although at ordinary pressures and temp the conc of non-volatile sulphur in a gas at equilibrium is given by the vapour pressure of sulphur and is not dependent on the gas, at high pressures and temp the gas assumes some of the properties of liq and dissolves solids and other liq to an extent dependent on the nature of the gas and the solute.

Sulphur is sometimes present in reservoirs producing natural gas, and must be in the vapour phase, with the possibility of deposition on pressure and temp drop. The deposition may be in the rock near the well bore, reducing permeability, and in the tubing. Suitable pressure control may allow the general site of deposition to be fixed. Moreover, there is the possibility of injecting gas to obtain sulphur from subsurface deposits. Hydrogen sulphide at 5000 psi and 200° F dissolves 5·6% by wt of sulphur.

Apparatus is described for measuring the solubility of sulphur in pure methane, carbon dioxide, hydrogen sulphide, and in three binary mixtures of the three pairs of gases, as well as in three ternary mixtures. The pressures were 1000–6000 psia and the temp 150°, 200°, and 250° F. The solubility increased with rise in pressure and temp; it was highest in hydrogen sulphide and least in methane (at 250° F and 6000 psia the solubilities were 30·96 lb, 461·58 lb, and 10·323 lb/mcf for methane, carbon dioxide, and hydrogen sulphide respectively). G. D. H.

157. Interference between oilfields. W. Hurst. *J. Petrol. Tech.*, July 1960, **12** (7), 70 (summary).—By means of the Laplace transformations, reservoir pressure implicity expressed in the material balance equation can be made explicit, and a function of the factors contributing to the change. Specific isolation of pressure for a water-drive field can be transcribed to any field in the aquifer to give the increased pressure drop on that field. Mathematical treatment is possible for interference between fields of different areal extents and located at different distances apart.

Two approaches have been developed, and analytical treatment of interference between oilfields is possible with only a desk calculator. G. D. H.

158. High volume pumping pays off in the Rockies. R. W. Parker. *World Oil*, Sept 1960, **151** (4), 71.—High vol pumping equipment has been used successfully in problem wells in the Rocky Mountain area. Submersible centrifugal electrical pumps have been fitted, and these have increased ultimate recovery from reservoirs having a low recovery factor under conventional pumping conditions. The theory, design, and applications of high vol pumping equipment are discussed, with case histories of some installations in the Rocky Mountain area. It is essential that the ability of the well to support a high vol pump be initially determined and the vol of fluid required estimated. Although the basic need for high vol is economic, there are applications in, for example, highly fractured reservoirs where pressures are maintained by active water drives. The need for extensive well testing and appreciation of reservoir characteristics in the application of the method is emphasized. C. A. F.

159. "Unthawing" oil reserves. Anon. *Mech. Engng (N.Y.)*, Sept 1960, **82** (9), 78.—Brief details are given of an electronic oil-well heater developed by Raytheon Co, Norwood, Massachusetts, U.S.A. This heater utilizes deep-penetration radar beams, produced by special electronic generators of very high frequencies. It is hoped that the heater will increase the yield of many wells, and tests are planned for various depths and types of rock formation. D. W. G.

160. Natural gas sources in Southwest France. A. W. Mayer. *Ingenieur, 's Grav.*, 23.9.60, **72** (39), A509; 30.9.60, **72** (40), A521.—Vast underground natural gas reservoirs were discovered at St Marcet in 1939 and at Lacq in 1951.

The field at Lacq is 15 km long, 7 km broad, and has a depth of 3260 m. The gas consists of 70% methane and 5% higher order hydrocarbon gases. Mercaptans, H_2S, and COS, etc., are removed on a treating plant at Lacq before the gas is distributed into an extensive pipe network. Widespread safety installations and precautions against pipe fracture are maintained on the pipework grid delivering the gas to and from the treating facilities. The treating facilities recover ethane and higher order hydrocarbons, and there is a sulphur recovery installation. The national distribution network is fully described with the help of a map, and the operation of the network and the underground buffer storage reservoirs is also mentioned. The commercial background of the operating companies is briefly described. D. C. E. de W.

161. Why sucker rods fail. J. Zaba. *Oil Gas J.*, 19.9.60, **58** (38), 99–100.—Fatigue, or corrosion fatigue, is the commonest cause of sucker rod failure. The fatigue may be brought on by wear or improper field handling of the rods; magnetic methods of inspection allow flaws to be detected. Threaded connexions must be pre-loaded by making up to the correct degree of tightness. J. C. M. T.

162. Sucker-rod constants. J. Zaba. *Oil Gas J.*, 17.10.60, **58** (42), 115–16.—Design calculations for sucker-rod strings require the use of many dimensional and other constants; in this article tables give wt/gas at 60° F of oils of different API gravity; dimensions, wt, and stretch of API standard rods; conversions of fluid gradient to wt of fluid for various size plungers; and also a graph of stress/working load for various dia rods. J. C. M. T.

OILFIELD DEVELOPMENT

163. Home markets offer growing outlet for Texas–Louisiana gas reserves. R. L. Conkling. *World Oil*, Sept 1960, **151** (4), 84.—An intensive survey of local markets in Texas and Louisiana has shown that the best area for future natural gas sales will be within these states, in spite of the rapid growth of interstate pipelines. *Ca* 90% of consumption in the two states is for industrial purposes, compared to *ca* two-thirds in the whole of the U.S.A. Charts show major Texas and Louisiana industrial markets and marketed production of natural gas, and a table gives a forecast of the states' natural gas demands. C. A. F.

164. Simplified log interpretation. 3. T. Walker. *Petrol. Engr*, Aug 1960, **32** (9), B70.—This part continues the discussion of the interpretation of logs obtained with the focused logging tools described in an earlier part. Charts are provided to simplify saturation calculations. Examples are given of information obtained by radiation-induction and radiation-guard logging in specific formations. G. D. F.

TRANSPORT AND STORAGE

165. Gas "bubble" storage. D. Hale. *Petrol. Engr*, Aug 1960, **32** (9), D29.—Experimental tests being carried out by the Northern Illinois Gas Co are described: it is proposed to store natural gas underground beneath a flat cap rock and surrounded by a wall of injected water. The formation requirements for this type of storage to be successful are given. G. D. F.

166. Solving gas-hydrate problems. L. E. Connealy. *Oil Gas J.*, 3.10.60, **58** (40), 116–21.—A number of methods for preventing gas hydrate formation are considered. Heating of the gas stream will prevent hydrates, but has its drawbacks in the cost of equipment and fuel. Injection of glycol into the gas is a further solution, and since it remains in the liq phase it can be separated, re-concentrated, and re-used. Less glycol is required then methanol, because an appreciable portion of the methanol stays in the vapour phase. On the other hand, expensive re-concentration and storage equipment is necessary with glycol, the former being subject to fouling by any salts dissolved in the water produced with the natural gas. Furthermore, glycol coats the periphery of the tube, the amount required being about 34·5 gal/inch-mile. Methods of breaking down gas hydrates forming in a pipe are considered, the most practical one being to isolate the portion of pipe and blow to atmosphere. A. D. S.

167. Adapting fork trucks for fluid handling. Anon. *Fluid Handl.*, 1960, 225–6.—At Dalton's Belper factory, use of pallets and fork trucks enables max use to be made of height of drum store; 50-gal steel barrels can be moved, 15 at a time, by fitting detachable tubular extension forks. Fork trucks are also used for loading demountable tanks (150–600 gal) on to road cars, accurate control being required as clearance is limited, and for conveying open-top tubs (with built-on pallets) of molten material within the works. Brief description of trucks is given. W. A. M.

168. The right COS can reduce pumping costs. T. J. Sniffen. *Petrol. Engr*, Aug 1960, **32** (9), C40.—It is shown that for economical centrifugal pumping installations, accuracy and completeness of the conditions of service (COS) used in requisitioning pumps are necessary. The paper mentions the penalties of over-specifying pumps, either through inadequate data or by allowing too generous safety factors in the system design. G. D. F.

169. Argentine project—a unique pipeline contruction. F. H. Love. *Petrol. Engr*, Aug 1960, **32** (9), D14.—An extensive description is given of a dual gas and products pipeline system recently constructed for the Yacimientos Petroliferos Fiscales between Campo Duran in N Argentina and Buenos Aires (gas line) and the YPF refinery at San Lorenzo. The constructing companies are listed. The construction methods and terrain crossed are mentioned; a discussion of the required corrosion protection is included. Aux equipment, such as compressor stations, pumps, metres, gathering system, etc., are described. The gas line is of 22- or 24-inch dia and 1100 miles long, while the products line is 12-inch dia and 900 miles long. G. D. F.

170. How Mid-America was built. Anon. *Oil Gas J.*, 10.10.60, **58** (41), 130–61.—The Mid-American pipeline includes a number of features representing advanced modern practice. The control is centred for best operation, the entire 2200-mile line of 4-, 6-, 8-, and 10-inch pipe being regulated by the dispatcher from a 28-in push button console in the main office. All the pump units were standardized to reduce costs of maintenance and of housing spares. The system has two main operating terminals, one to combine batches of products from the gathering systems into tenders for movement N into the main line, and the other to receive and store products from the producing area for movement into the marketing area at rates necessary to satisfy seasonal demand. There are seven distribution terminals, all following the same design and layout for simplification of operation and maintenance. Since LPG is one of the products handled, large vol, low cost pressure storage is essential. Caverns dissolved out of naturally occurring salt deposits are used, and in five units there is a storage capacity of 300,000 brl. The power services are carefully planned, half-duplex dc channels being used to operate pulse-code transmitters. The main line of this system is 1685 miles long and was divided into six sections to facilitate control of the construction spreads. It was water tested to a minimum pressure of 1584 psi, on sections between pump stations approx 100 miles in length. All the pipe has a tensile stress of 42,000 psi, and gasoline plant lines were wrapped with polyethylene tape for corrosion protection. A. D. S.

171. From Hassi-Messaoud to the Mediterranean. Anon. *Fluid Handl.*, 1960, 248–9.—Extracts from articles in *Travaux* deal briefly with laying of crude pipeline from Hassi-Messaoud oilfield to terminal at Bougie (533 km of 24-inch; 127 km of 22-inch), pumping stations, and layout of terminal and harbour at Bougie. W. A. M.

172. What are future pipeline needs? A. C. Barkow. *Oil Gas J.*, 10.10.60, **58** (41), 211–25.—Most important need for future pipeline is improved weldability in the range of conditions encountered in pipeline construction. High strength steels are required for large dia thin-wall pipe, without loss in ductility and lower transition temp, and elimination of cleavage-type ruptures is becoming increasingly more important. Notch insensitivity is a property that must be developed, and better control of chemical and physical composition must be provided. The latter can now be achieved

by non-destructive testing and other means. Pipe of closer tolerances must be produced, both at the ends and in the middle. Cutting to remove defects must be limited, because a high percentage of short lengths means increased construction costs. Improvement of visual-inspection in the pipe mill, at the unloading sites, and in the field will reduce trouble and failure in the completed line. Finally, the need for correlation between field experiences and lab and mill tests must be developed, and new test methods are needed.
A. D. S.

REFINERY OPERATIONS

REFINERIES AND AUXILIARY REFINERY PLANT

173. How cap spacing sets tower design. L. S. Gyökhegyi *et al. Petrol. Refin.*, May 1960, **39** (5), 201–6.—An equation is derived for determining the max vapour or gas capacity of bubble cap towers, knowing the cap sizes and spacing.
M. J. M.

174. How to estimate fractionating column costs. N. H. Prater and D. W. Antonacci. *Petrol. Refin.*, July 1960, **39** (7), 119–26.—Elementary design and cost factors are presented for unit prices of fractionating towers.

Details of a sample calculation are given in the article.
M. J. M.

175. Soup up older plants for more C_3 and C_4 recovery. H. W. Barber. *Petrol. Refin.*, April 1960, **39** (4), 124–6.—Nine methods are given for increasing propane and butane recovery from old plants. They range from inexpensive operational improvements to major equipment additions. M. J. M.

176. Impact of recently developed processes on refining technology. R. C. Kersten and G. F. Asselin. *Petroleum, Lond.*, 1960, **23**, 341.—Some of the probable future trends in refinery operation are outlined. It is thought that there will be improved motor and road ON, that gaseous olefins will be increasingly used as alkylation feed, that the quantity and quality of jet fuels produced will increase rapidly, and, finally, that hydrocracking processes will become increasingly important. Various processes currently being used for improving gasoline quality, alkylation, normal paraffin removal, to provide jet fuels of high quality, and hydrocracking are outlined, with special reference to processes developed by the Universal Oil Products Co. Some research on fuels for providing transparent flames is also mentioned. G. D. F.

177. The behaviour of catalytic cracking catalyst in vertical risers. S. Stemerding. *Ingenieur, 's Grav.*, 16.9.60, **72** (38), Ch 121.—Lab investigations into the behaviour of cat cracking cat was performed in 2-inch dia vertical risers of various lengths using air and steam as transport gases, under various conditions of temp and pressure. The experimental evidence showed the pressure drop over the riser to be a function of the particle wt, the friction at the wall, and the particle acceleration, and to be independent of the visc and density of the transporting gas.

A relationship between the Froude No. and the apparent slip factor was established. The true slip factor and the friction factor were shown to be functions of the riser length only. The apparent slip factor is shown to be related to the true slip factor, a friction factor, and the particle acceleration. Several diagrams show the experimental results.
D. C. E. de W.

DISTILLATION

178. Distillation—theory and fundamentals. J. A. Gerster. *Industr. Engng Chem.*, 1960, **52**, 645.—A review of recent advances in the theory and fundamentals of dist is presented. The importance of having accurate vapour–liq equilibrium data is stressed, and newly available data and correlations are summarized for non-ideal mixtures. Various procedures are considered for making multi-component tray-to-tray calculations by use of computers. Recent advances in the prediction of tray efficiencies are also reviewed. M. F. M.

179. Distillation—the practical aspects. H. W. Haines, Jr. *Industr. Engng Chem.*, 1960, **52**, 662.—Following points are singled out as important factors in design and operation of dist columns: choice of the correct system, selection of appropriate control methods, automation, efficient use of equipment, and accurate cost estimate. Standardization, where possible, saves time and money. Methods are suggested to help an "organized approach" and to shorten the gap between academic training and practical viewpoint. M. F. M.

180. Distillation-equipment design. M. G. Fryback and J. A. Hufnagel. *Industr. Engng Chem.*, 1960, **52**, 654.—A broad classification of commercial dist columns is made into two categories: (1) dist involving an overhead and bottoms product either or both of high purity, and (2) fractionation of a mixture into a multiplicity of cuts, without sharp separation. The paper deals essentially with practical design aspects of the columns in the first category.

It is important to consider column requirements as related to the overall plant, i.e. capacity range, design reflux ratio, type of tray, column sizing, and the aux equipment design. The costs of the latter are frequently as high, or higher, than the tower itself, and such equipments are frequently sources of trouble because of bad design. M. F. M.

181. Pressure drops in packed columns. Generalized method of estimation for single phase flow. (In French.) R. H. Crowther, R. G. Taecker, and L-T. Fan. *Chim. et Industr. (Genie Chim.* suppl.), 1960, **84**, 73–81.—A generalized procedure to cover all types of single phase flow is presented for estimating pressure drops in packed columns by taking into consideration shape of individual particle and packing density so that the equation can be used for both expanded or loosely packed and rigidly packed beds with either streamline or turbulent flow. As a measure of packing density, the hydraulic width of particle, surface divided by mean projected perimeter, is compared with hydraulic radius, free space divided by packing surface. An empirical correction factor is applied to theoretical coeff for streamline flow, α. The turbulent flow coeff, β, is related empirically to particle shape and packing density. (Authors' summary.)

ABSORPTION AND ADSORPTION

182. Estimate ethylene–methane separation. W. A. Mason. *Petrol. Refin.*, May 1960, **39** (5), 233–6.—The separation of methane and ethylene can be obtained by absorption or fractionation; two charts are presented, from which the separation can be estimated for the two processes. Details are included of the theory and simplifying assumptions made in deriving the charts. M. J. M.

CRACKING

183. Add oxygen for better cat operation. J. A. Rabo and J. B. Powers. *Petrol. Refin.*, July 1960, **39** (7), 161–3.—Tests were made on a 22,500-bd fluid cat cracking unit. By the use of oxygen-enriched air the regenerator efficiency was

improved and the coke content of the cat was reduced to below 0·1 wt% in a shorter contact time. Oxygen addition rates up to 150,000 cfh were used, resulting in an increase of coke burning capacity to 69·5% from 60·5% conversion. The reaction rate effects and conditions in the regenerator are discussed. Best results are obtained when the oxygen is used in an aux regenerator treating partially regenerated cat.
M. J. M.

184. How cat feed made by deasphalting. J. G. Ditman and J. Dunmyer, Jr. *Petrol. Refin.*, May 1960, **39** (5), 187–92.—The theory of propane deasphalting has been summarized and cases in which the process is particularly advantageous are reviewed. Cat cracking feed is recovered from vacuum residues treated in a propane deasphalting unit. Data are given for refinery realization for Menao and Arabian crudes; a max yield of kerosine plus virgin diesel fuel was assumed. With the introduction of the unit, No. 6 fuel oil production is halved and gasoline and dist oil production is increased. The economic advantages of the process are given. M. J. M.

185. Hydrocracking tried on a large scale. J. Varga *et al.* *Petrol. Refin.*, April 1960, **39** (4), 182–4.—Details of the large-scale testing of the Varga process are given. The process is intended for the hydrocracking of high asphalt crudes and their residues. The flow diagram for the 120,000 tons/day plant is given; utility and chemical requirements are reported.
M. J. M.

HYDROGENATION

186. Gulf HDS turns residue into cat feed. H. Beuther and R. A. Flinn. *Petrol. Refin.*, April 1960, **39**, (4), 143–8.—Atmospheric and vacuum residues are converted into cat cracking feeds by hydrogenation at high pressures. Details of the cracking characteristics of gas oils produced at 1000 psig and 3000 psig are reported. At the higher pressure the basic nitrogen remaining in the gas oil is reduced by 50%, and a higher yield of gasoline is obtained. M. J. M.

ALKYLATION

187. Alkylation-unit process review. L. F. Albright and R. N. Shreve. *Industr. Engng Chem.*, 1960, **52**, 533.—The article is a review of papers published during the past two years on carbon–carbon, carbon–oxygen, carbon–nitrogen, carbon–silicon, and carbon–aluminium alkylation. It gives comprehensive tables of reactants and cat used in various processes and also the products obtained from each process. An extensive list of refs is also given. M. F. M.

ISOMERIZATION

188. Kinetics of catalytic isomerization of *n*-pentane. N. L. Carr. *Industr. Engng Chem.*, 1960, **52**, 391.—Isomerization of *n*-pentane was studied in a flow reactor containing a solid cat to obtain information about kinetics and to use the data for the design of reactors. Use was made of statistical methods. Several mathematical models were fitted to the data, and three were shown to be statistically adequate. One of these models, representing the Hougen and Watson approach, was consistent with the dual-site, surface-reaction-controlled cat model. Another model based on simple kinetics, but including intra-particle diffusion, was employed to estimate the importance of the particle size of the cat on both apparent kinetics and reactor size. M. F. M.

189. Get octanes with the Isom process. W. H. Decker. *Petrol. Refin.*, April 1960, **39** (4), 201–4.—The Iso-Kel process is used for the isomerization of the pentane and hexane portions of a gasoline; process variables are 700°–800° F and 100–750 psig. Experimental results are reported for the testing of the process in a small-scale isothermal reactor system. Techniques applied in the choice and testing of a cat are given. M. J. M.

CHEMICAL AND PHYSICAL REFINING

190. Carbonyl sulphide in natural gas processing. J. L. Arnold, C. K. Hall, and R. L. Pearce. *Oil in Canada*, 18.7.60, **12** (38), 33–8.—The reactions of COS with aq mono- and di-ethanolamine have been studied. Both ethanolamines effectively remove COS from natural gas. Mono-ethanol-amine, but not di-ethanolamine, is subject to loss by the formation of reaction products which are not regenerated.
G. B.

SPECIAL PROCESSES

191. How to make and use C_4 olefins. Pt 1. L. F. Hatch. *Petrol. Refin.*, May 1960, **39** (5), 229–32.—A review is made of the production and principal uses of the C_4 olefins, the butenes. Refinery streams account for 85% of butene production, the remainder is from the dehydrogenation of butane. The process operating conditions for the production of the main chemical derivatives of butene are briefly described.
M. J. M.

192. Use these K's in hydrofining. J. M. Prausnitz and J. H. Duffin. *Petrol. Refin.*, May 1960, **39** (5), 213–22.—This article includes data for K values of hydrocarbons in the C_4C_{10} region which are in contact with hydrogen in the pressure range 500–250 psia. The results were obtained by use of an electronic digital computer; the theory of the method is reviewed. The authors claim the results are true to within 10%; a comparison of calculated and observed K values is given for hexane and decane. M. J. M.

193. Gaseous hydrocarbons by hydrogenation of coals and chars. R. W. Hiteschue, R. B. Anderson, and D. Friedman. *Industr. Engng Chem.*, 1960, **53**, 577.—Hydrogenation of coals and chars to gaseous hydrocarbons was studied as a technique for augmenting the future supply of natural gas. It was found that lignite and bituminous coals were more reactive than char or anthracite at 800° C and 6000 psig. Char and anthracite produced high yields of gaseous hydrocarbons and no oil. Small amounts of coronene were also obtained from anthracite. Bituminous coals and lignite yielded moderate quantities of gaseous hydrocarbons and modest amounts of low boiling oil. In all cases hydrocarbon gases contained *ca* 90% methane, 9% ethane, and 1·0% propane.

Results can be used to design a small continuous unit for a more intensive study of the hydrogenation of coal to high Btu gas. M. F. M.

194. Desulphurization of petroleum coke during calcination. F. Sulf. *Industr. Engng Chem.*, 1960, **52**, 599.—Carbon electrode industries require petroleum coke with a low sulphur content, which is produced today from selected raw materials. The process of desulphurization of petroleum coke is therefore steadily gaining in importance. The desulphurization of petroleum coke can be accomplished at calcination temp to 850° C. As much as 90% of the sulphur originally present can be removed from a finely ground petroleum coke with hydrogen as fluidizing medium. The desulphurization is improved by reducing the particle size and increasing the pressure and space velocity. M. F. M.

195. Desulphurization of petroleum coke. S. J. Lukasiewicz and G. C. Johnson. *Industr. Engng Chem.*, 1960, **52**, 675.—A trend in petroleum refining is the production of coke having

a higher sulphur content. One way to reduce the sulphur content is to calcine the coke in the presence of sodium carbonate or sodium sesquicarbonate. The process consists of four steps: (1) pulverizing the coke to pass a 60-mesh screen; (2) adding an alkaline reagent; (3) calcining; and (4) cooling, leaching with water, and drying. M. F. M.

196. New data for hot carbonate process. H. E. Benson and J. H. Field. *Petrol. Refin.*, April 1960, **39** (4), 127–32.—Typical flow schemes are given of the hot potassium carbonate process for purifying acid gases to pipeline specification. Tables for steam savings by the use of ejectors are given for a plant of capacity 25 million cu ft/day. The net steam consumption is reduced from 34,700 lb/hr to 17,300 lb/hr. Simultaneously, cooling of the regenerated soln is achieved. Commercial plant performance has been compared with pilot plant data. It is concluded that to minimize steam consumption the size of the absorptive and regenerative columns should be relatively large to obtain a greater approach to equilibrium. M. J. M.

197. Get cheaper coking now with this new design. A. L. Saxton *et al.* *Petrol. Refin.*, May 1960, **39** (5), 157–60.—The fluid coking process has been redesigned, resulting in a saving in investment and running costs. Heavy residium is fed into the reactor. The fluidized coke bed is between 900° and 1000° F. The thermal conversion products leave as overhead vapours. Re-design features are elimination of unnecessary aux equipment, integration of a waste gas turbine, change to the coke burner, and a new plant layout. M. J. M.

198. Fluor solvent CO_2 removal process. A. L. Kohl and P. A. Buckingham. *Petrol. Refin.*, May 1960, **39** (5), 193–6.—The economics and plant description of the Fluor solvent CO_2 removal process for purifying high pressure gas streams of high concn carbon dioxide are reported. The gas stream is treated in a countercurrent absorption column. Hydrocarbons absorbed in the solvent are removed in a flash tank, and are then compressed and recirculated.

An economic comparison has been made of the Fluor solvent process with the Rof potassium carbonate, Giammarco–Vetrocoke, and water wash processes for a plant capacity of 100 mmscf day feed gas at 800 psig. M. J. M.

METERING AND CONTROL

199. Control computing. 1. G. Post. *Petrol. Engr*, Aug 1960, **32** (9), D31.—The requirements of a computer for control work are outlined, and brief mention is made of the advantages of computer control over the use of ordinary automatic controllers. There types of computer—analogue, digital, and incremental digital—are compared under various considerations, *e.g.* costs, speed, reliability, etc. The advantages and disadvantages of each type are tabulated for easy reference. G. D. F.

200. Short cut to pressure-drop calculations. J. O. Ball. *Oil Gas J.*, 3.10.60, **58** (40), 99–102.—The method developed is short, simple, and accurate for all cases which have been checked. It uses only those variables which are found in the standard Fanning pressure-drop eqn and the Reynolds No. It can be used to determine the pressure-drop for turbulent flow of varying density fluids—liq, gases, or mixtures of the two—in short lengths of process piping such as condensing coils and furnace tubing. A number of numerical examples are given. A. D. S.

201. "Set-point" control governs system. Anon. *Oil Gas J.*, 3.10.60, **58** (40), 112–13.—"Set-point" control is being used by Colorado-Interstate Gas Co in the first stage of an automatic system. The method provides for the control of a single condition—in this case, the discharge pressure. The set point is determined by the operator at the control centre, which sets the discharge pressure at the station. Controls there do the rest of the work in adjusting conditions so that they result in the prescribed discharge pressure. This system, which is shown diagrammatically, has been in operation some six months without trouble. A. D. S.

202. Simulate your refinery on a computer. R. C. Shea. *Petrol. Refin.*, April 1960, **39** (4), 169–72.—Factors to be considered in a refinery simulation programme are given. Details of the calculation sequence for the cat cracking section are an example. Feed specification, material balance, heat balance, product yields, operating costs, and optimizing steps are discussed. M. J. M.

203. How good are pipeline control systems? H. A. Brainerd. *Oil Gas J.*, 10.10.60, **58** (41), 164–88.—A series of tests carried out by Sinclair Pipe Line Co, in co-operation with seven major instrument companies, showed that much improvement is needed, and outlined areas where most of the work should be done. The elaborate, detailed tests also led to nine essential characteristics of a good pipeline control system. These are: to minimize unwanted overshoot in responding to fast changes from an "off" control position, the controller must be capable of stroking the valve before the set point is reached; regardless of the system, the control valve must always be capable of changing pressure on the line at a more rapid rate than the rate of pressure change of the worst upset condition; all lags in the control loop must be kept to an absolute minimum to obtain fast stable action; a suction-discharge controller will give a better performance with an isolated rather than a common feedback system; controller should be designed to allow accurate set point adjustments easily; the output signal should be only a little greater than the value needed to stroke the control valve 100% of its travel; the system should either be capable of responding stably to a wide change in control loop gain or have a variable gain feature to compensate for variable control valve gain; it should be no more complicated than necessary to do the job, and should be capable of slow start-up so that the pump drive is not overloaded during this condition. A. D. S.

PRODUCTS

CHEMISTRY AND PHYSICS

204. Frictional properties of molybdenum disulphide films containing inorganic sulphide additives. A. J. Haltner and C. S. Oliver. *Nature, Lond.*, 1960, **188**, 308.—Powders of molybdenum disulphide plus 10% inorganic sulphide were compressed into pellets, which were then rubbed against steel for several hours to produce a film. Frictional properties were measured between the steel and a ¼-inch dia chrome steel hemisphere moving at 70 cm/sec and loaded in 50-g increments until failure, as indicated by a sudden increase in friction, occurred. The coeff of friction was not greatly affected by the different additives, but the max load increased from 0·3 kg for molybdenum disulphide alone to as much as 5·8 kg in the presence of antimony sulphide. Similar results were obtained when the molybdenum disulphide was replaced by tungsten disulphide. H. C. E.

205. Hydrocracking of neopentane and neohexane over evaporated metal films. J. R. Anderson and B. G. Baker. *Nature, Lond.*, 1960, **187**, 937.—Propane, neopentane, and neohexane were each reacted with hydrogen over evaporated

films of nickel, tungsten, platinum, and rhodium, and the reaction products were analysed by gas chromatography after 5–25% of the hydrocarbon had reacted. It was found that hydrocracking of neopentane and propane on nickel, tungsten, and platinum occurred easily, and the order of cat activity for hydrocracking at the quaternary C atom is Rh > W > Ni > Pt, the same order as for propane. On Pt, neopentane isomerized substantially to give 17% of *n*-butane. For neohexane, cracking at the quaternary C atom (indicated by isobutene and ethylene in the reaction products) was marked on Pt and decreased in the order Pt > W ⩾ Ni > Rh, the later cat yielding mainly neopentane and methane.

These results indicate that hydrocracking of a C–C bond can occur without 1–2 diadsorption (*i.e.* adsorption at adjacent C atoms). It is postulated that in hydrocracking reactions, where 1–2 diadsorption is sterically impossible, the reaction proceeds via 1–3 diadsorbed species and that diadsorbed intermediates are comparatively strongly adsorbed by the loss of H atoms from at least one C atom. H. C. E.

206. Z's for propane and methylacetylene. P. D. Dawson and J. K. McKotta. *Petrol. Refin.*, April 1960, **39** (4), 151–4.—Experimental results are given in graphical and table form for the compressibility factors of propane and methylacetylene in the range 0–1600 mm mercury and −30° to +75° C; accuracies of ±0·04% were claimed. The isotherms are linear within the limits of accuracy of the range of variables studied. M. J. M.

207. Applied hydrocarbon thermodynamics. Pt 16. W. C. Edmister. *Petrol. Refin.*, April 1960, **39** (4), 193–9.—Ten charts are given for estimating the true bp assays of equilibrium vapour and liq from flash vaporization of petroleum fractions. Sample equilibrium flash vaporization calculations are given to illustrate the advantages of the integral method. M. J. M.

ANALYSIS AND TESTING

208. Rolling bearing performance test for lubricating greases. The Mechanical Tests Panel of IP Standardization Sub-Committee D. *J. Inst. Petrol.*, 1960, **46**, 328–33.—This paper outlines the development of the proposed rig, from its inception to the final form described in IP 168/59T. In this rig, two bearing assemblies are mounted on a horizontal spindle capable of being run at speeds up to 10,000 rev/min. The test bearings can be heated to 150° C and loaded to 300 lb radially. A test procedure was developed and co-operative work undertaken. The results obtained correlated well with known field performance of the greases examined, despite certain differences in rig design outside the test bearing assembly. Results of tests which used bearings with cage floats restricted to 0·015–0·030 inch gave better precision than those with cage floats in excess of this figure. The successful development of a cage float measuring fixture made possible exact wear measurements as an important criterion of grease performance. The final standardized rig design as adopted in IP 168/59T is illustrated. A. D. S.

209. Determining density variation of light hydrocarbon mixtures. J. K. Elliot and P. H. Kelly. *J. Petrol. Tech.*, July 1960, **12** (7), AIMME Tech. Paper No. 8121, 170–4.—Surface metering and lab compressibility check points call for the use of liq densities of light hydrocarbon mixtures at various pressures and temp. No simple reliable method existed for determining density variation, especially for liq of unknown composition. Studies have aimed at deriving densities, knowing only the density of the liq at some condition. For liq of unknown composition methods have been examined which employ: (1) a modified Tait equation; (2) modified Standing method (liq compressibility and expansibility curve in conjunction with the additive vol–apparent density method); and (3) the use of Sage and Lacey's data to give a set of liq density curves involving pressure, temp, and mol wt. Method (3) gave an average error of less than 0·5% when comparisons of predictions were made with extensive lab compressibility data. When liq density–mol wt curves cannot be used the modified Standing method seems best. The apparent density method seems preferable when the composition of the light liq hydrocarbon mixture is known. G. D. H.

210. Confirm trace component identity. H. W. Martin. *Petrol. Refin.*, April 1960, **39** (4), 161–4.—The article describes a method of obtaining the identity of impurities which cause product quality or specification problems in dist systems. The method is applied to plant data, and is based on an estimated tray efficiency for the trace component separation. The identity of the impurity is obtained from the vapour–liq equilibria, which are determined from the measured column separation. A worked example is given, and limitations of the method are included. M. J. M.

GAS

211. Producing natural gas substitutes from petroleum by continuous pressure hydrogenolysis. E. B. Schultz, Jr, N. Mechales, and H. R. Linden. *Industr. Engng Chem.*, 1960, **52**, 580.—High thermal value gas produced by thermal cracking of petroleum has a high olefin content and is not directly substitutable for natural gas. High yields of olefin-free 800–1000 Btu/Scf fuel gas were obtained at 500–1500 psig and 1400° F by continuous hydro-gasification of dist oils or their equivalent. Carbon-forming materials from the crude and residual oils were first removed by hydrocracking at 850° F over cobalt molybate.

By incorporating commercial methods of hydrogen supply, integrated process schemes for continuous production of natural gas substitutes from low value petroleum oils can be developed from these data. The only by-products are *ca* 10% low boiling aromatics. M. F. M.

212. Pipeline gas by methanation of synthesis gas over Raney nickel catalyst. H. A. Dirksen and H. R. Linden. *Industr. Engng Chem.*, 1960, **52**, 584.—The synthesis gas methanation step in conversion of coal to high Btu gas is complicated by cat problems and the large heat of reaction. Performance of fluid-bed cat prepared from nickel–aluminium alloy was improved by precise control of activation, handling, and start-up. In 1-inch dia reactors, *ca* 20,000 Scf of methane/lb of original alloy were produced in 1200–1500 hr at 75–150 psig from purified synthesis gas, with a 3 : 1 hydrogen/CO ratio.

Further cat improvement and better reactor design should permit better yields and lower costs of cat, which at present is estimated at 5 c/1000 Scf of methane produced. M. F. M.

213. Natural gas in Israel. Anon. *Petroleum, Lond.*, 1960, **23**, 340.—This brief paper mentions two new discoveries of natural gas in Israel, with possible industrial outlets for this new source of energy. Plans for a plant to manufacture polyethylene are also given. G. D. F.

214. Pipeline gas by high-pressure, fluid-bed hydrogasification of char. E. J. Pyrcioch and H. R. Linden. *Industr. Engng Chem.*, 1960, **52**, 590.—Direct hydrogenation of coal to methane would have a relatively high thermal efficiency for producing natural gas supplements. Smooth fluid bed operation at 500–2000 psig and 1400°–1500° F has been achieved with a low-temp bituminous coal char in a semi-continuous pilot plant.

At char feed rates of 20–90 lb/hr/cu ft of bed vol, gases of

up to 700 Btu/Scf were produced in a 5-ft deep bed at hydrocarbon space–time yields ranging from 150 to 700 Scf/hr/cu ft of bed vol. From 15 to 60% by wt of the char was hydrogasified. These data indicate that by the use of more reactive feeds, deeper beds, or multi-stage operation, gases approaching natural gas heating values can be produced.

M. F. M.

215. A management look at natural gas. W. B. Golush. *J. Petrol. Tech.*, July 1960, **12** (7), 11–16.—Marketed gas production increased 218% from 1948 to 1958, and 11 × 10^{12} cu ft of gas was sold in 1958. A 5% pa growth rate is predicted for the next ten years. Petroleum increased its percentage share of the energy demand (excluding transportation) from 39% in 1948 to 59% in 1958; it may rise to 62% in 1968. Where gas competes, the percentage of petroleum energy supplied by gas rose from 54% in 1958 to 63% in 1958, and may go to 72% by 1968.

To ensure adequate supplies it is considered that the reserves-to-production ratio should be at least 20 years, but this would provide full pipeline deliverability for only 12–15 years, because of the problems of obtaining gas associated with oil, and the state of depletion and drive in non-associated fields. The above ratio requires discoveries to be twice the output, for a 5% pa growth rate. Allowing for imports and an excess of reserves at the end of 1958, discoveries must average 26 × 10^{12} cu ft pa for the next ten years to meet expected needs; this rate has not been reached in the past.

Total U.S. ultimate gas recovery has been estimated at 1350 × 10^{12} cu ft.

Exploration efforts must be intensified. One major producer placed unit finding and developing costs at 11 c/million Btu in 1950 and at 18 c/million Btu in 1958, without allowing for taxes, lifting costs, or return on investment. It has been suggested that average well-head prices in 1968 should be 19 c/Mcf for gas and $3·5 for crude; if crude remains at 1958 prices the gas should be 29 c/Mcf. Certainly doubling of the 1958 figure of 11·9 c seems necessary. Price adjustments should be allowed on existing contracts.

Pending acceptable solutions to the regulation problems, exploration should be concentrated in areas offering incentives in prices, with sales preferably where well-head revenues are greatest.

G. D. H.

ENGINE FUELS

216. New charts give better clues on vapour-forming qualities of motor fuels. O. C. Bridgeman and E. W. Aldrich. *Oil Gas J.*, 3.10.60, **58** (40), 108–9.—Two simple charts are presented for evaluating the vapour-forming characteristics of motor fuels from a knowledge of Rvp and the slope at the 10% point of the dist curve. Summation of values from the two charts gives the temp corresponding to any given vapour–liq (V/L) ratio up to 50 at any barometric pressure from 560 to 760 mm Hg. The results apply to true V/L ratios, which are determined from the equilibrium vol V of vapour per unit vol L of residual liq, on an air-free basis. Application to vapour lock test data requires the use of true V/L ratios rather than apparent V/L ratios as given by the CRC charts, which do not include the necessary corrections to an air-free basis. An example of how to use the charts is given.

A. D. S.

217. Property requirements for liquid rocket propellants. E. M. Goodger. *J. Inst. Petrol.*, 1960, **46**, 314–27.—The performance characteristics of propellants are considered under the headings of reaction energy, specific impulse, and combustion characteristics. Handling characteristics are discussed in terms of vol impulse, vapour pressure, thermal stability, visc–temp relationship, heat capacity, combustion characteristics, uniformity, availability and cost, and storage, transfer, and transport. The overall suitability of hydrocarbon, liq hydrogen, slurries, hydrides, and oxidants as fuels are critically assessed. It is concluded that a high heat of reaction is a basic requirement for a rocket propellant pair, but this is modified by the thermodynamic behaviour of the combustion gases in the propelling nozzle. A high combustion temp is necessary for high thrust, but cooling problems are intensified, and certain propellants only are suitable as coolants. A general increase in specific and vol impulse is found with a decrease in sp gr of the propellant mixture. Liq hydrogen offers the ultimate in specific impulse, but handling difficulties are severe. Liq fluorine is the most energetic reacting medium available for use with rocket fuels. Hydrocarbons still represent a practical compromise for rocket applications, with non-carbon hydrides as second choice. Slurry fuels, on the other hand, are more suited to air-breathing propulsive units.

A. D. S.

DERIVED CHEMICAL PRODUCTS

218. Preparation of acetylene. F. Rosendahl. *Chim. et Industr.*, 1960, **84**, 357–74.—Most of C_2H_2 is obtained by H_2O on CaC_2. Excluding this process, survey is given of other methods: hydrocarbon transformation (partial combustion of CH_4), pyrolysis (of C_2H_6, C_4H_{10}, crude petroleum fractions), action of electric arc on CH_4 and other hydrocarbons in modern improved types of furnaces. (Author's summary.)

219. Petroleum products in the manufacture of synthetic fibres. (In French.) P. W. Sherwood. *Chim. et Industr.*, 1960, **84**, 382–94.—Survey (technical, industrial, economic) of petrochemicals use in this field. Three groups considered: nylon, raw materials for which are adipic acid, hexamethylene diamine, caprolactam; acrylic, based on acrylonitrile and various polymers: polyester, prepared from terephthalic acid and ethylene glycol. Source and preparation of raw materials and processing thereof indicated; actual and forecast market statistics given.

(Author's summary.)

220. Styrene–crude oil to polymer. E. V. Anderson, R. Brown, and C. E. Belton. *Industr. Engng Chem.*, 1960, **52**, 550.—Cosden Petroleum Co makes 20 million lb pa of polystrene in its Big Spring, Texas, plant. It is the only producer to get its ethyl benzene directly from a mixed xylene stream. To do it the company uses a 600-ft superfractionator, removes ethyl benzene from a stream in which its nearest bp component is only 3·9° F away. Cosden plans to increase its styrene output to 60 million lb annually and hopes to get additional ethyl benzene from the UOP Alkar unit.

M. F. M.

221. Recent production and further processing of chemicals from petrochemical raw materials. (In German.) E. Kotter. *Erdöl u. Kohle*, 1959, **12**, 236–40.—IV. Naphthenes; aromatics; various petrochemical processes and reactions. Saturated cyclic hydrocarbons (*cyclo*paraffins or naphthenes) exist in straight-run gasoline to 50%, with 5–6 C-atoms, and are derivatives of *cyclo*pentane or *cyclo*hexane. Separation of naphthenes from crude oil requires special methods. Oxidn of *cyclo*hexane at 50° C gives adipic acid used in nylon production. Nitration of *cyclo*hexane gives nitro*cyclo*hexane processed to perlon. Highly chlorinated *cyclo*hexanes are important insecticides. Modern petroleum refining processes: hydroforming, platforming, the catarole process, Udex process, octafining (for separating C_8-aromatics) are used for separating the important aromatic hydrocarbons. Chlorination, oxidn, nitration, etc., of aromatics with cat, temp and pressures used, products and particularly firms are discussed. A final section deals with ethylene glycol and glycerine. 28 refs.

R. T.

CORROSION

222. Underground corrosion and methods of control. 6. O. C. Mudd. *Petrol. Engr*, Aug 1960, **32** (9), D39.—This final part of the series commences by considering the importance of cathode area segregation, *e.g.* by insulated flanges installed piping systems. A design for such an insulated flange is included. It is shown that adequate bonding between buried structures may do much to overcome corrosion caused by stray currents. Some of the bodies having recommended procedures for bonding are mentioned. The need for adequate records of underground structures, etc., is stressed. The economics of corrosion prevention are outlined, and this part ends with a summary of the whole series of articles. G. D. F.

223. Corrosion of steels in hot gases. (In German.) H. Keller. *Chem. Ing. Tech.*, 1960, **32**, 582.—It is shown that in the cracking of petroleum oils very high temp may be required, which lead to conditions conducive to the corrosion of ferritic steels, particularly in the presence of impurities, of which sulphur and vanadium are specially considered. The thermal stability of these steels may also be a limiting factor in their use. Preliminary experiments have been carried out under operating conditions to show the limiting temp which can be used under these conditions. G. D. F.

224. Corrosion mitigation in and on a major gas pipeline. J. A. Stewart. *Oil in Canada*, 25.7.60, **12** (39), 34–41.—Measures adopted by Westcoast Transmission Co are described. Different sections of the line were coated with asphalt or Trenton wax and with Polyken tape on the discharge side of compressor stations. Cathodic protection by impressed current from rectifiers was installed. In remote locations the current was provided by gas motor generators. The system was divided into sections by insulating flanges. The pipe interior was protected against wet sour gas by precoating with an inhibitor and subsequent continuous injection of inhibitor. G. B.

ENGINES AND AUTOMOTIVE EQUIPMENT

225. Main line diesel locomotives. Fuelling and lubricating services. Anon. *Fluid Handl.*, 1960, 255–8. Description of locomotive servicing station at Clarence Yard, London. Oil-fired boiler provides steam for heating. Sump oil is supplied through a network of pipes to metering points, from which bottles or stillages can be filled. Diesel fuel is fed from storage tanks to loading bays (not described). Controls are largely automatic with built-in safety devices. W. A. M.

ECONOMICS AND MARKETING

226. Selection of plant capacity. R. D. Newton. *Petrol. Engr*, Aug 1960, **32** (9), C10.—It is shown that before the optimum size of a plant expansion can be determined, several factors have to be taken into account, including sales, costs and investments, profit levels, etc. These factors are discussed individually, and some simple mathematical approximations are suggested for providing adequate prediction data. Finally, it is shown that flexibility of operation must be studied in conjunction with a " break-even " chart for the plant size selected. G. D. F.

227. Some considerations in the pricing of natural gas. K. E. Hill. *J. Petrol. Tech.*, July 1960, **12** (7), 17–18.—The average price of 12 c/Mcf at well-head makes natural gas *ca* one-fifth the price of crude in terms of Btu. New contracts in Texas and Louisiana are for 16–24 c/Mcf. However, transport costs to distant markets are *ca* five times those for crude on an energy basis. At 20–24 c/Mcf in S Louisiana, gas may be barely competitive with other fuels in New York. A low well-head price is essential for gas to compete in distant markets. At the newer prices there seems a good return on investment as compared with exploration and development for crude oil. Natural gas is being emphasized in many oil company exploratory budgets, and development gas wells fell off relatively less than development oil wells from 1956 to 1958. G. D. H.

MISCELLANEOUS

228. Newer organic chemicals in metals in metal protection and lubrication. J. K. Aiken and S. W. Critchley. *Petroleum, Lond.*, 1960, **23**, 338.—Some examples of the importance of organic chemicals in a wide field of metal treatment are given. The important properties in the following categories are listed, together with examples of suitable chemicals: wetting agents, complexing agents, corrosion inhibitors, EP additives, ester oils, and hydraulic fluids. G. D. F.

229. Evaluate plant design with this simple index. J. Happel and W. H. Kapfer. *Petrol. Engr*, Aug 1960, **32** (9), C34.—A new concept, termed the " venture profit," is defined and discussed. Using certain simplifications, which are clearly stated, expressions are derived for this quantity in terms of income, tax, depreciation, etc. Two worked examples using published data are provided to show the application of the method: the optimum boiler blowdown is determined in the design of feed water treating facilities, and the optimum number of working shifts per day for a given set of plant conditions is found. G. D. F.

230. How to determine rate of return after taxes, quickly, easily. C. D. Williams and P. B. Crawford. *World Oil*, Sept 1960, **151** (4), 80.—Charts are presented enabling a prospective purchaser of an oil property to estimate rapidly and simply the amount which can be offered for a required rate of return after taxes. Trial and error calculations are not required. The use of the chart is described with examples. Eight refs. C. A. F.

231. Thermal and catalytic decomposition of hydrocarbons—unit process review. A. J. de Rosset and C. V. Berger. *Industr. Engng Chem.*, 1960, **52**, 711.—This paper is an extensive review of the literature of the past year covering thermal decomposition, cat cracking, cat reforming, and dehydrogenation of hydrocarbons. M. F. M.

232. Nitrogen oxide formation in auto-ignition of liquid fuel sprays. G. J. Mullaney. *Industr. Engng Chem.*, 1960, **52**, 529.—Formation of nitrogen oxides in complex flames has been studied using a shock tube technique. The data ob-

tained may be helpful in considering methods of reducing nitric oxide, which is an important factor in air pollution.

At an air temp of 950° K before fuel injection, air pressure of 17 atm, and a time interval of *ca* 25 m sec, the nitric acid yield varied markedly with fuel. 2-propanol and ethyl alcohol produced very low yields. There is some evidence that nitrogen–oxygen kinetic data at high temp can be used to estimate the amount of nitric oxide formed in the diffusion flame following auto-ignition. Its exponential dependence on the temp suggests that control of the max combustion temp in engines will have a large effect on nitric oxide formation. M. F. M.

233. Australia, the search continues. Anon. *Petroleum, Lond.*, 1960, **23**, 329.—The early work in the search for oil in Australia is outlined. Small quantities of oil, gas, and condensate have been discovered at Puri in Papua, and Port Campbell in Victoria. The new Petroleum Search Subsidy Act of 1959 is mentioned. The activities up to May 1960 in Queensland, New South Wales, Victoria, S Australia, W Australia, N Territories, and Papua–New Guinea are outlined, with a map of some of the concessions. The current work and prospects are given briefly. G. D. F.

234. India invites oil capital. E. V. Corps. *Petrol. Engr*, Aug 1960, **32** (9), B59.—A brief history of the early search for oil in India leads to a short section on the geology of the country. Modern India petroleum legislation is outlined, and the activities of the Oil and Natural Gas Commission are mentioned. Current exploration and pipeline construction are dealt with briefly. The remainder of the paper surveys the India oilfields of Digboi, Nahorkatiya–Hugrijan, Moran, and Badarpur. G. D. F.

235. Crude oils of the United Arab Republic. II. M. A. Borham and A. Mustafa. *Petroleum, Lond.*, 1960, **23**, 346.—Physical and chemical data from tests on UAR crudes are given. It is shown that the sulphur and salt contents of the crudes are relatively high, and the methods used for combating refinery corrosion are mentioned. The consumption of various petroleum products (gasoline, kerosine, gas oil, asphalt) is given in some detail. G. D. F.

BOOK REVIEWS

Advances in Petroleum Chemistry and Refining. Vol. 3. Ed. John J. McKetta, Jr. New York; London: Interscience Publishers, 1960. Pp. xvi + 544. 126*s*.

The reader who will profit from this book must persevere. It has been written by 17 contributors and the chapters are of unequal merit; one never knows when it is suddenly going to be good, and this keeps alive interest of a kind. Externally the book is a dull brown and the title is not visible at one yard unless favourably illuminated, so that in a bookcase it might be difficult to find. Once the book is opened it is seen to be well produced and very well printed.

The reviewer found in the first chapter, " Economics of Petrochemicals," such careless and diffuse use of words that he was kept annoyed until the end. Few technical men in industry today wish to ignore economic studies, but it is still necessary in a technical publication that they be clearly presented. Is there really any difference between a " reasonably explicit positive " definition and a definition? One wonders exactly what work the two adjectives and one adverb were intended to perform in the reader's mind. The chapter on " Liquid Thermal Diffusion " is well done, but a clear statement of what prevents or limits commercial application is missing, as are comparative analyses of intake and products. The reviewer believes that little of the chapter on " Fired Tube Heaters " could not have been written in 1940. It is good and clear but not new, and the post-war impact of high intensity combustors on furnace design is not considered. There is a competent discussion of hydrocarbon isomerization, over 60 pages of text, but the equipment used on a commercial scale is not described.

At p. 193 the reviewer began to enjoy the book. The 90-page account of hydrogenation is comprehensive, clear, up-to-date, and does look ahead with vision. There follows a short and brisk account of post-war developments in hydrofluoric acid alkylation. Hydrocarbon oxidation does not include ethylene to ethylene oxide, commercially one of the most important and interesting, but what it is allowed to include is well described. Petrochemical acetylene is well covered and there is a welcome chapter on sulphur compounds in petroleum. The final chapter on cooling towers seems out of place in the book; one would prefer a review comparing air and water coolers, as this is the aspect of the subject that exercises many refiners today.

Good bibliography after each chapter and indexes complete the work. Great minds have been employed, but in only two or three of the ten chapters do they seem to make contact with the reader or perform the work of interpreter. Six guineas is a lot of money. D. P. P.

Chemical Processing Nomographs. Dale S. Davis. New York: Chemical Publishing Co., 1960. Pp. 255. $12.

This book is substantially a collection of nomographs taken from recent issues of the journal *Chemical Processing*. The selection is edited and introduced in a breezy and colloquial manner by Professor Davis. The treatment is successful, since so much of the space is devoted to factual nomographs, tables, relationships, and examples.

There is little doubt that the devising of nomographs has become a kind of cult with some engineers, who appear to pursue the subject almost for its own sake.

The justification for a nomograph is often that it enables a calculation to be made with greater speed, convenience, or certainty than by other methods. It is thus in competition with the slide rule, calculating machine, graph, and numerical table.

A substantial number of the nomographs in this book merely perform operations of multiplication and division. In these cases many engineers would prefer to use a slide rule on the basis of space and time saving. However, where logarithmic terms or fractional powers would require the use of a slide rule with log log scales, the case for a nomograph becomes stronger. The solution of the Dittus Boelter equation for heat transfer is an example of this.

Where an experimental or empirical relationship is involved which cannot be expressed in simple algebraic form, the nomograph is often more convenient than multiple entry tables. Unfortunately, these are the most difficult nomographs to construct and are relatively rare.

A particularly useful group of nomographs involves the relationship of temperature with physical properties such as vapour pressure and viscosity. These nomographs express a considerable quantity of data in far less space than would be possible using tables or graphs and, furthermore, interpolation is not required. It is an unfortunate omission that vapour–liquid equilibrium data is not dealt with in the book, as this topic would be particularly useful and suitable for nomographic representation.

K

The material is arranged in 15 chapters or units dealing with various topics, starting with a review of the principles of nomograph construction, and continuing through heat transfer and fluid flow to the largest section dealing with the physical properties of systems. The concluding topics include costing, equipment sizing, and conversion of units.

An important aspect of this book is its use as a convenient source of data for various process calculations. L. G. M.

ADDITIONS TO THE LIBRARY

Entries are in subject order arranged according to the Uren "Classification for Petroleum Bibliography," the number preceding each entry indicating the classification and corresponding to that used in the "Library Catalogue" published by the Institute.

020 British Standards Institution. Annual report, 1959–60. London, BSI, 1960. 282 p.

020 Scientific and Learned Societies of Great Britain. Scientific and learned societies of Great Britain: a handbook compiled from official sources. 59th ed. London, Allen and Unwin Ltd, 1958. 215 p.

022 Imperial College of Science and Technology. The Royal Charter of the Imperial College of Science and Technology: jubilee 1907–1957. London, Imperial College, 1957. 37 p.

041 National Petroleum Bibliography. Petroleum sourcebook, 1959. A regional bibliography of petroleum information. Amarillo, Texas, National Petroleum Bibliography, 1960. 234 p.

050 World List of Abbreviations. World list of abbreviations of scientific, technological, and commercial organizations. 2nd ed. London, Leonard Hill [Books] Ltd, 1960. 300 p.

080 Scientific Instrument Manufacturers Association *and* United Science Press Limited. British instruments: directory and buyers' guide, 1960. London, United Science Press Ltd, 1960. Various paging.

080 United States Steel. USS Oilwell: drilling and producing machinery and equipment, 1960–61 catalog. Dallas, Texas, USS, 1960. 128 p.

082 Iraq Petroleum Company Limited. Iraq oil in 1959. London, IPC, 1960. 32 p.

094 Council of British Manufacturers of Petroleum Equipment. Report of the exploratory mission to the Argentine and Chile. London, CBMPE, 1960. 18 p.

113 Canada. Department of mines and technical surveys. Mineral resources division. The Canadian mineral industry, 1956. Ottawa, The Queen's Printer. . ., 1960. 447 p.

113 Canada. Department of mines and technical surveys. Mineral resources division. Petroleum refineries in Canada. Ottawa, The Queen's Printer, 1959. 28 p. Operators list 5.

113 Canada. Department of mines and technical surveys. Mineral resources division. Summary of developments in the Canadian mineral industry, 1958, by B. F. Burke. Ottawa, The Queen's Printer. . ., 1959. 33 p.

115 Suter, H. H. The general and ecomomic geology of Trinidad, B.W.I. 2nd ed. London, HMSO, 1960. 145 p.

202 American Chemical Society. Abstracts of papers, 138th meeting, New York, September 11 to 16, 1960. Washington, ACS, 1960. Various paging.

213 Opfell, John B., Pings, Cornelius J., *and* Sage, Bruce H. Equations of state for hydrocarbons. New York, API, 1959. 184 p.

234 Emmett, Paul H. Catalysis. New York, Reinhold. . Vol. 7. Oxidation, hydration, dehydration and cracking catalysts. 1960. 378 p.

290 Price's (Bromborough) Limited. The analysis of fatty acids and fatty alcohols. Bromborough Pool, Birkenhead, Price's (Bromborough) Ltd, 1960. 149 p.

303 Congrès Geologique International. Commission de stratigraphie. Lexique stratigraphique international. Paris, Centre National de la Recherche Scientifique [195–?]. Vol. III. Asie, Fascicule 10a Iraq. 1959. 333 p.

670 American Society for Testing Materials. Symposium on bulk quantity measurement. . . Philadelphia, ASTM, 1958. 50 p.

700 Institution of Chemical Engineers *and* Institute of Petroleum. The organisation of chemical engineering projects, joint symposium held at Olympia, London, W.14 on 24, 25 and 26 June, 1958. London, Institution of Chemical Engineers, [1960]. 144 p.

729 United States. Department of commerce. Office of technical services. Mechanism of the oxidation of hydrocarbons, by Cecil E. Boord. Washington, US Department of Commerce, 1958. 116 p.

740 Association of British Chemical Manufacturers. Chemical plant instrumentation: some notes on the use of measuring instruments. London, ABCM, 1960. 55 p.

817 Le Mesurier, L. J., *and* Humphreys, H. S. Fuel consumption and maintenance costs of steam- and diesel-engined vessels. London, E. and F. N. Spon Ltd, 1935. 46 p.

910 Degolyer and MacNaughton. Twentieth century petroleum statistics, 1960. 16th ed. Texas, Degolyer and MacNaughton, 1960. 186 p.

910 Ministry of Power. Statistical digest, 1959. London, HMSO, 1960. 179 p.

910 United Africa Company Limited. Statistical and economic review: issue 24. London, United Africa Co. Ltd, 1960. 41 p.

934 Association of British Chemical Manufacturers. The chemical industry, a career for you. London, ABCM, 1960. 29 p.

935 Fire Protection Association. Industrial solvents and flammable liquids. 2nd ed. London, FPA, 1959. 24 p.

950 Campbell, John M. Oil property valuation. Englewood Cliffs, N.J., Prentice-Hall, Inc., 1959. 523 p.

960 Brunner, Christopher T. Large-scale organisation and change: a study in oil marketing. London, Royal Society of Arts, 1958. 35 p.

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OILFIELD EXPLORATION AND EXPLOITATION

GEOLOGY

236. Where is the basement? H. T. Brundage. *World Oil*, Oct 1960, **151** (5), 170.—A knowledge of the depth to basement in sedimentary basins is crucial in the search for oil and gas. A table shows max depth to basement in various sedimentary areas, and these are discussed. Deepest basement is in the U.S.A. Gulf Coast, where it is estimated to be at 50,000 ft; by contrast the crest of the Nemaha Ridge in Kansas is at a depth of *ca* 1000 ft. In other areas depths are as follows: Texas, Red River Uplift (2300 ft); Sumatra (5000 ft); Paris Basin (8000 ft); Chile, Tierra del Fuego (12,000 ft); Algeria, Hassi Messaoud (12,600 ft); W Canada (15,000 ft).

C. A. F.

237. West Texas strike hits three pools—maybe five. F. J. Gardner. *Oil Gas J.*, 3.10.60, **58** (40), 143.—A wildcat following a seismic survey which showed a structural uplift in Ector County, Texas, has been completed in the Ellenburger limestone at *ca* 13,000 ft for 441 bd of 54° oil. Later the well was also completed in the Permian Wolfcamp at *ca* 8500 ft for 189 bd of 41° oil and in the Silurian Fusselman at 12,220 ft for 352 bd of 48° oil. Total restricted capacity is thus *ca* 1000 bd. Oil had not been found in substantial amounts previously in the area, and there are now good prospects for multi-pays in the vicinity. Hitherto dry holes and marginal fields had been found.

C. A. F.

238. Deep South Texas trend bustles with activity. F. J. Gardner. *Oil Gas J.*, 7.11.60, **58** (45), 205.—1 Kunkel in NW Karnes County, S Texas has found gas and condensate in Lower Cretaceous Edwards at *ca* 10,700 ft, and other wells in the area have recently been successful in establishing production from the Deep Edwards trend which extends some 200 miles from the Rio Grande to Lavaca County. Wells in this play are sparse, and the nature and extent of the deep reservoirs are problematical.

C. A. F.

239. Southwest Texas exploration centres on Edwards trend. Pt 1. G. R. Pinkley. *Oil Gas J.*, 21.11.60, **58** (47), 262.—A series of deep oil and gas fields has been found in a zone extending *ca* 200 miles from the Rio Grande NE to Lavaca County, Texas. Pays are from 9000 ft to below 14,000 ft, and there are deeper prospects. 18 gas, three oil, and one oil and gas field have been found. The area is marked by many

N

strike faults affecting a wedge of sediments thickening down-dip to the SE. Surface mapping is possible only in a few places. Deep structures have been located by seismic work, and drilling has shown that there is a series of unconformities with structure increasing in intensity with depth. The location of fields, which produce from the Lower Cretaceous Edwards limestone below a Tertiary sequence, involves interpreting the palæogeology and buried structures below the old Cretaceous surface. In the gas fields porosity of the Edwards ranges up to 20%, and recoveries are estimated at 700–1000 Mcf gas/acre ft. C. A. F.

240. Lisbon anticline hottest area in the Paradox Basin. Anon. *World Oil*, Nov 1960, **151** (6), 89.—Mississippian and Devonian targets are being sought along the Lisbon anticline in Utah and Colorado. *Ca* 18 wells have been drilled in the area, where production has recently been found in the Palæozoic at *ca* 8000 ft. Gas was found at 1·2–17 MMcf/day in the Mississippian and oil at 587 bd of 44° gravity in the Devonian McCracken sandstone. This is the first report of commercial Devonian production in the area, and it is thought to be one of the most important recent wells in the U.S.A. Other wells in the area have been promising, although some dry holes have been drilled. The area is characterized by salt cored anticlines within the Paradox Basin, paralleling the Uncompaghre Uplift forming the NE boundary. Activity in the area is increasing, and there is heavy leasing. C. A. F.

241. Dig deeper for Ouachita reserves. W. D. Pitt. *Oil Gas J.*, 14.11.60, **58** (46), 214.—Recent finds of gas in Ordovician rocks of the Potato Hills area of the Ouachita Mts show that these old rocks in the mountain area can be suitable reservoirs, and it is indicated that the Ouachitas have an important future as a potential oil and gas area. In a recent discovery the reservoir was fractured Big Fork chert which has an effective fracture porosity. Other potential reservoirs are Crystal Mountain sandstone and older rocks, such as the Lukfata sandstone. Some of these are highly cemented with dolomite or calcite, but certain beds at surface show high permeability, possibly due to weathering. Thickness of sediments below the oldest exposed rocks in the mountains is estimated at up to more than 20,000 ft. Oil possibilities of selected areas are briefly reviewed. Seven refs. C. A. F.

242. Nebraska play strides northwest. F. J. Gardner. *Oil Gas J.*, 7.11.60, **58** (45), 213.—Reports indicate that the first major oilfield has been found for Nebraska. 1 Stroup, a wildcat in Dundy County, found Pennsylvanian oil from *ca* 4150 to 4300 ft in the Lansing-Kansas City formation. The well is *ca* 2 miles NE of an old dry hole which found pre-Cambrian basement at 5100 ft. If the well proves commercial a wide area in this E lobe of the Denver Basin will be of potential interest. The new well abuts the E flank of the Las Animas arch. Most prospects are probably stratigraphic. There has been recent successful drilling between the Las Animas arch and the Cambridge arch. C. A. F.

243. Independents can play the deep country too. P. Bike. *Oil Gas J.*, 31.10.60, **58** (44), 217.—A successful wildcat has been completed in Grady County, Oklahoma, in an area where there has been relatively little drilling. Gas with condensate was found in two Ordovician zones: the first Bromide at 11,708–11,771 ft, which produce 31 MMcfd, and the Bromide sand at 11,776–11,814 ft, which flowed 3680 Mcfd, with 92 brl condensate/million cu ft after mud acid treatment. Old seismic records were reinterpreted before selecting the location, and evidence indicated good fault trap prospects. C. A. F.

244. Ten-year search may be on verge of a pay-off. J. C. McCaslin. *Oil Gas J.*, 24.10.60, **58** (43), 165.—After *ca* ten years of sporadic exploration for Devonian production in the Williston Basin of Montana, a well has found commercial oil from the Nisku formation. The test, 1 Sletvold, flowed 87·1 brl/hr from *ca* 7700 ft. Most production in the basin comes from prolific Mississippian reservoirs, particularly along the Nesson anticline and Cedar Creek. Devonian stratigraphy is now fairly well established, and it has been shown to occur throughout the Williston Basin, but has varying thickness and characters. The formation has good shows and widespread porous zones. C. A. F.

245. Drillers keep busy in Northern Kansas. D. F. Merriam. *Oil Gas J.*, 17.10.60, **58** (42), 164.—There is active exploration in NW and NE Kansas, where there have been some important discoveries. In NE Kansas five fields have been found along a 35-mile trend of the Alma anticline, and these have a considerable economic importance. Oil is produced from Lower Palæozoic rocks. The stratigraphy and structure of the Alma anticline are discussed: overlying the pre-Cambrian basement are Cambrian through to Permo-Pennsylvanian rocks, the older Palæozoics being largely limestones or dolomites and the younger being mainly shal·s and limestones. The axis of the anticline follows the trend of the Nemaha ridge which lies to the W, and there is evidence of faulting along part of the E limb. Many subsurface folds have surface expression, and the trend of the anticline is shown by small surface closures. The proven fields on Alma are in closed anticlines found by core-drilling, surface mapping, and seismic work. Future prospects are outlined, and structural maps of the Alma region are included. C. A. F.

246. Northern Arizona has good oil, gas prospects. S. C. Brown and R. E. Lanth. *World Oil*, Sept 1960, **151** (4), 98.—In spite of recent active exploration, the only small commercial oil and gas wells in Arizona are producing from the foreland facies zone of the Hermosa Paradox in the extreme NE part of the state in the Paradox Basin. The regional geology of N Arizona is described: there are two distinct basins, the Paradox to the N and the Black Mesa to the S. There have been good shows in widely scattered wells, and there are potential reservoir rocks in the Fort Apache and Devonian. The stratigraphy of the area is outlined. 23 refs. C. A. F.

247. West Africa. G. de Mohrenschildt. *Oil Gas J.*, 24.10.60, **58** (43), 166.—Oil prospects and developments in W Africa are reviewed with special reference to Ghana, Togoland, and Dahomey. These countries have a coastal belt of sedimentary rocks flanked in the interior by pre-Cambrian granites and metamorphic rocks. Tertiary deposits along the coast are covered by recent river deposits which can reach 400 ft. Most of the outcropping sedimentaries are Eocene and Cretaceous and are continental in character. The general dip of the sediments is 1–2° to the S, with occasional E–W strike faults of *ca* 350 ft throw. Geophysical surveys indicate a positive axis trending NE to SW. In Ghana there is the Voltaian Basin of Cambro-Ordovician age containing Ordovician to Devonian deposits. Oil shows have been found in several areas, including Togoland, which in part is included with the large Nigerian Basin, in which seven oilfields have been found in the past three years. Considerable production has also been found in the Cameroons, Gabon, French Equatorial Africa, and the Gulf of Guinea. Many sedimentary basins which were formerly thought to be quite unfavourable for oil accumulation have recently been found highly productive. C. A. F.

248. European drilling sets fast pace. Anon. *Oil Gas J.*, 31.10.60, **58** (44), 218.—Active exploration and development is under way in Europe after a slow start following world war II. There are three broad geological provinces: (1) Scandinavia, devoid of young rocks and basins; (2) N Europe, containing broad sedimentary basins and large areas of older rocks; and (3) the Mediterranean region with high mountains

lined by narrow sedimentary troughs, and intervening intermontane sedimentary basins containing young rocks. A map shows *ca* 16 basins of interest in Europe and the most important are: (1) Carpathian, extending E–W over Central Europe; (2) N German, extending E–W through Poland and N Germany into E England; (3) Hungarian Basin; (4) Vienna Basin; (5) Molasse Basin in Switzerland; (6) Po Basin; (7) Aquitanian Basin in France; and (8) Paris Basin. Exploration in 1959 led to the finding of 28 oilfields and 22 gas fields, mostly in France and W Germany. An important field was found in the Paris Basin at St Martin de Bossenay, in which Mid-Jurassic limestone is productive; seismic structure indicated a N-trending faulted anticline. Production is 940 bd from five wells. In the Aquitaine Basin Cretaceous production was found at Cazaux; four wells produce 1383 bd. 14 oil and seven gas fields have recently been found in W Germany, making a total of 97 oil and 23 gas fields on production. Production increased by 11% to 99,250 bd in 1959. Wildcats are mainly drilled on seismic structures on borders of known Jurassic troughs or on structural highs within basins. Salt dome flanks are being carefully studied. Many traps await drilling. Operations in Italy, Sicily, and Jugoslavia are briefly noted. C. A. F.

249. North-West German salt domes and their importance for oil accumulation. (In German.) G. Richter-Bernburg and W. Schott. *Erdöl u. Kohle*, 1959, **12**, 294–303.—A profusely illustrated article is presented on tectonic structure and development of salt plugs and oilfields at salt plugs. In the relationships between salt plugs and oilfields in NW Germany an unconditional assumption for oilfield formation is alone sediment deposit sufficiently thick with certain spatial extension. Petroleum deposits can occur in very varied tectonic structures. Salt structures—diapirs or salt cushions—in no wise are an unconditional assumption for petroleum deposit formation. Illustrations comparing salt plug distribution and sedimentation basins show clearly the dependence of all NW German oilfields on large synclines of the Jurassic and Cretaceous sediments; also independence of many oilfields of salt structures. Salt is indisputably very important for productive structure formation, but salt plugs are only one type of tectonic structure which offer possibilities for accumulation. Since migration and accumulation of the oil to deposits occurs already during structure formation, the study of salt movements is of practical val. Stages or phases seen in salt movements are accumulation—diapirism—subsequent movements. Salt accumulation, *i.e.* amassing above the primary thickness, can proceed in every salt formation. Diapirism—true salt plug formation—requires assumption of primary salt thickness ≮400 m, deep sinking in epirogenetically sinking zones, and bursting of faults in the roof formation; sinking or bursting are mostly gradually differing results of the same geotectonic lability. Bursting through of the diapirs is somewhat eruptive as a result of sudden pressure release by fault bursting, and prefers the orogenetically active moments of geohistory. Subsequent movements may be absent or comprise an uplifting with diapiric moments. In NW Germany activity of the diapirs shifts regionally, corresponding to the migration of the Mesozoic and Tertiary trough depths. Adjacent salt plugs therefore have largely similar history, and thus offer similar petroleum-geological problems. 34 refs. R. T.

250. Migration, tectonics, and oil deposits in the Gifhorn trough, NW Germany. (In German.) F. Hecht. *Erdöl u. Kohle*, 1959, **12**, 303–15.—Migration of originating oil, tectonic movements of the earth's crust, and oil reservoir genesis in the Gifhorn trough have acquired deeper insight by deep drilling and reflection seismics. The Gifhorn trough is the E extension of the NW German Basin, wherein—especially during Jurassic times—sedimentation of very thick shales with high org substance cont, favouring oil formation, occurred. Movements, *e.g.* before and during Cretaceous times, gave the trough form and structural character—uplifts, marginal fissures, normal and antithetic faults, salt plugs, salt cushions, and transgressions. In the Gifhorn trough the sandy part of the sedimentation sequence of Jurassic, Upper Jurassic, and Lower Cretaceous age—capable of oil reservoir formation—running parallel to the above formations of the different structures, simultaneously reached a structural position favourable for such oil reservoir formation. Discovery of their genesis and geological history permits conceptions as regards direction, vol, age, and speed. The originating oil migrated from the central deep to the peripheral marginal part, as with oil reservoirs near salt plugs, in anticlines, and faults. Migration of the oil of the Hohne anticline is assumed during the Liassic, of most other reservoirs during the fault system of an age before Cretaceous time. Oils of different transgression traps show oxidn indication soon after sedimentation of the transgressing covering beds of Lower Cretaceous. Sp gr, gas–oil ratio, and bubble-point are important indicators for age and migration depth. High bubble points and high gas–oil ratio indicate migration and reservoir development below a thick sediment cover, or at great depth in the trough centre. Low bubble point and low gas–oil ratio at the NW trough edge indicate migration in low depths. This condition existed at the end of the Lower Cretaceous under thick sediments in the central part of the Gifhorn trough, and much reduced beds of Lower Cretaceous at the periphery. Nine refs. R. T.

251. Structure of the folded molasse in Western Bavaria with relation to the molasse-foreland and adjacent parts of the Alps investigated by geophysical investigations. (In German.) F. Breyer and G. Dohr. *Erdöl u. Kohle*, 1959, **12**, 315–23.—The folded Molasse in the W part of the Bavarian pre-Alps was investigated by means of geological mapping in detail, reflection seismics, and gravimetric measurements. Results of seismic measurements—supported by charts—permitted a tectonic analysis down to depths of at least three miles. Overthrust structures were found to extend to this depth and to reach S into the adjoining Helveticum and Flysch areas. Close relationships between them were detected. Analysis of tectonic events at different geological times was attempted. It is hoped that the results will give an impulse to further exploration for oil. 22 refs. R. T.

GEOPHYSICS AND GEOCHEMICAL PROSPECTING

252. A new approach to geophysical methods of finding oil. A. Roy. *Oil Gas J.*, 7.11.60, **58** (45), 208.—It is estimated that 75% of production in the U.S.A. in the future will come from stratigraphic traps, but there are no conventional geophysical methods which can detect such traps as routine. Only in exceptional cases can gravity or seismic reflection indicate features such as reefs and sand lens development. Moreover, these methods can locate reliably only a very small proportion of the structural traps available; this is because of errors in depth interpretation due to unavoidable errors in velocity data. Small features will therefore remain undetected. Established simpler methods of prospecting, such as the geochemical and radioactive methods, are reviewed, and it is concluded that they are in general economical and are neglected for this reason. It is suggested that the industry dislikes simple and cheap methods of prospecting, partly for reasons of prestige. C. A. F.

253. Seismic mapping of fault zones in the Central and Northern parts of the Upper Rhine graben, and their importance for oil accumulation. (In German.) J. Andres and A. Schad. *Erdöl u. Kohle*, 1959, **12**, 323–34.—Detailed reflection seismic

surveys made in past years in the Rhine Valley graben have disclosed numerous faults and fault systems. Seismic methods used are discussed. Wells drilled on the basis of information obtained by seismic surveying found oil and gas mainly at antithetic faults. Relevant profiles and contour maps are added for explanation. Velocity logging in the boreholes gave information about velocity dependence on depth, facies changes, and age. It was possible to draw a map of top Oligocene showing the intricate fracturing of the investigated area. Some cross-sections through this area show the faulted structure, also changes in sedimentation thickness of the graben. The close connexion between tectonics and oil and gas reservoirs assisted in discovery of numerous fields with the help of seismic prospecting. 12 refs. R. T.

DRILLING

254. Care and maintenance of tool joints. Pt 1. S. G. Marshall and C. R. Frederick. *World Oil*, Oct 1960, **151** (5), 117.—Recommendations are made for the care and maintenance of tool joints and drill collar connexions, and causes of tool joint failure are discussed. Shoulders can be cut and damaged from jacking stand of pipe around with wrench. A metal fin on tool joint shoulder can develop when pin or box is mated with smaller dia box or pin, and other examples of damage are illustrated with photographs. Periodic inspection by qualified personnel should be carried out, and care should be taken not to apply excessive torque, *e.g.* the upper limit of recommended torque for the 4-inch API internal flush connexion is 16,000 lb/ft, and this will yield a 2⅞-inch API internal flush connexion. The magnitude of stresses during rotation is influenced by the weight and size of the string, the static or built-in stress produced when connexions are tightened, and other miscellaneous conditions. The table gives recommended make-up torque for connexions of different types and sizes. C. A. F.

255. Casing failures caused by thermal expansion. H. C. Humphrey. *World Oil*, Nov 1960, **151** (6), 105.—Several recent casing failures in S Texas have been analysed, and this has been shown to be due to compression such as hoop stress, buckling due to mud wt and thermal compression, increased mud wt, and forces of thermal expansion. These factors are analysed with examples, and recommendations are made for eliminating casing failure. These include: (1) a proper use of caliper survey to determine accurately the amount of cement required for cementation; (2) consideration of hydrostatic wt of fluid in designing casing string; (3) heating circulating fluid to counter thermal compression; (4) designing casing string individually; (5) cementation to the surface of intermediate string. This would minimize possibilities of buckling through intervals where horizontal forces are not sufficient to support thermal expansion conditions. C. A. F.

256. New sealed bearing unveiled—designed to lengthen bit life. Anon. *World Petrol.*, June 1960, **31** (6), 70.—A new bit is being commercially produced in which the bearings are lubricated and sealed against intrusion by drilling and formation fluids. This will give added life to insert bits, for example, which are designed for hard rocks such as chert. The bit legs in the new design contain a reservoir which supplies lubricant to the bearing whilst rotating. Pressure of the mud column enables the lubricant to move to the bearing surfaces. The bits have been field tested in W Texas and New Mexico, and tests show that they have an average life of two to three times that of non-lubricating bits. Cost will be 25–35% higher. C. A. F.

257. Development of drilling and production methods in Germany. (In German.) H-G. Goethe and E. H. Ladebeck. *Erdöl u. Kohle*, 1959, **12**, 423–31.—German petroleum recovery could look back to the time of the 4th World Petroleum Congress in 1955 on a satisfactory development. Steady oil production increase by oil companies to meet the growing demand for crude oil in the Federal Republic is reported. Increase of crude reserves is the result of intensive exploration, and a considerable trend towards deeper wells—leading to discovery of crude reserves—has been observed. Natural gas production has declined following market problems, but reserves show a gratifying increase. The growing demand of the Federal Republic for crude oil has led to acquisition of concessions abroad. Equipment modernization has contributed to increased footage/rig/year. German equipment manufacturers have contributed to this success. Turbine drilling is found to be a useful supplement to rotary drilling in Germany. Development towards better economy, rationalization, and, in some cases, towards automatic control of producing fields could be achieved. German reservoir engineers and oil company lab have improved the economy of fields by intense studies. Branches of foreign supply and service companies in W Europe are welcomed for their material and tech assistance. Further equipment modernization is under way, and training of supervisory personnel is becoming important. Exchanges of experience with foreign experts will stimulate German geologists and reservoir engineers, also drilling and production engineers. 74 refs. R. T.

258. What's the future of big-hole drilling. C. R. Woodruff, R. Sneed, and H. G. Bentson. *World Oil*, Oct 1960, **151** (5), 108.—Current trends indicate that it will be possible to drill boreholes with increasing dia, but factors to be taken into account in large dia holes include the problem of circulation, bit design, drill collar wt, and the means of handling large size tools. In recent years holes up to 36 inches dia have been drilled, such as those for subsidence control in the Wilmington field, California, where depths ranged up to 2400 ft. There are costly problems of designing special equipment and techniques and the accommodation of king-size bits and casing. Air drilling can be used in certain cases in drilling large holes, and this has been carried out in a 20-inch hole in hard sandstone; further development of this technique is required. Reamer bits and hole openers are very useful; they consist of three to four field-replaceable roller type cutters mounted on a specially designed integral body and a pilot attached to the lower end of the body to centre the tool in relation to a pilot hole. Jet circulation ensures rapid removal of cuttings. C. A. F.

259. New drift indicator cuts drilling time. G. M. Wilson. *World Oil*, Oct 1960, **151** (5), 134.—A simple signalling instrument has been developed for determining the drift angle of the borehole from the vertical. It is placed immediately above the bit in a 7-ft sub of the same dia as the drill collar. Readings are obtained as follows: the bit is lifted off bottom and rotation and mud pumps stopped. The mud pumps are started after 45–60 sec, and a series of pressure surges arrives at the surface through the mud stream, the number of pulses indicating the drift angle. Each pulse represents ½° of hole angle and is recorded on a chart. Readings may be taken as required. The tool operates by virtue of a series of internal restrictions in the form of annular rings which create a succession of pulses in the mud stream. A plunger extends along this series to a distance permitted by a small pendulum which moves along a series of graduated stop shoulders. Each successive stop represents an increment of dia angle. These increments can be adjusted if necessary, and the device generates a max of seven signals. The tool has been successfully tested in several areas, particularly in the Wheeler Ridge area of S California, where a basalt zone causes deviation problems. C. A. F.

260. How to forecast accurate drilling costs. O. E. Mecham and M. S. Legge. *World Oil*, Oct 1960, **151** (5), 112.—

Drilling contractors need to determine accurately cost factors on which drilling bids are based, so a means of accurately forecasting drilling costs is very important. A method of doing this is described using the profile technique of forecasting penetration rates and bit footages. (66–75% of footage price for an average exploration well is directly related to "variable" cost, *i.e.* net drilling time and drilling bits.) Other "fixed" costs, such as moving rig to location, can be forecast reasonably accurately. Drilling analysis charts are used in the profile method, and these show overall drilling progress, net drilling progress, and rotating progress. Wells and depth intervals are selected for study, and a well profile is prepared. Ft/day and ft/bit are determined for each interval, and weighted averages placed on the profile. Composite net drilling time and bit requirement curves can then be plotted and contractor days and bits determined. The method has been tested in many areas and found to be accurate when properly applied. It is a fairly lengthy procedure, but with experience an analysis can be made in 6–12 hr, depending on control data available. C. A. F.

261. Check list minimizes accidents while drilling with gaseous fluids. G. Jackson. *World Oil*, Oct 1960, **151** (5), 128.—Particular care is needed in using gaseous fluids as drilling media in order to minimize accidents. It is estimated that *ca* 10% of all wells drilled in the U.S.A. in 1960 will use air or natural gas. It is the responsibility of the operator to select a competent service company which is safety conscious, and safety measures should be thoroughly discussed, including the briefing of drilling crews. Check lists are presented for minimizing accidents; these are divided into: (1) prework safety planning; (2) rigging up; and (3) drilling. Two refs. C. A. F.

262. How to use the continuous velocity logger in core and shot holes. H. W. Hardy. *World Oil*, Oct 1960, **151** (5), 160.—The velocity log sonde has been developed for use in slim holes and is housed in a tool 3⅞ inches dia and 16½ ft long. The logger is completed as a single unit and on a mobile mount, so that logs from core and shot holes can readily be obtained. The log is similar to that obtained in conventional wells showing two curves for two spacings. Traces are for $\triangle t$, and by using a rolling planimeter the log may be integrated and travel times established for various intervals of logged depth. The log is very effective for correlation, and details of thin beds are shown. They can be used for velocity data *per se*. Field operation of the log is described and examples of typical profiles included. C. A. F.

263. Shell's offshore spud type mobile drilling platform. (In Dutch.) A. C. D. Boerstra. *Ingenieur, 's Grav.*, 28.10.60, **72** (44), W221.—A description is given of a self-contained mobile drilling platform owned by the Shell Group of Companies and operating in the Middle East. The pontoon measures 64 × 32 × 5·3 m and has eight legs measuring 67 × 2·80 × 2·88 m mounted on it. The pontoon is towed to a suitable position, and the legs are lowered and locked in position by means of hydraulic mechanisms. Several diagrams show the layout of the platform, and the construction of the legs. Detailed consideration is given to the stresses possible in the legs under the various operating and weather conditions. The unit is capable of drilling wells up to 4500 m in water depths ranging from 4·5 to 30 m. The platform houses workshops, power generating equipment, air-conditioned accommodation for 72 persons, and a helicopter landing deck. The approx total cost of the platform is £2,000,000. D. C. E. de W.

PRODUCTION

264. Downhole camera helps solve production problems. L. C. Fons. *World Oil*, Oct 1960, **151** (5), 150.—A downhole camera has been developed which has proved useful in solving drilling and production problems by photographing borehole conditions. The tool is 4½ inches dia and 4 ft long, and can be operated up to 200° F and 4000 psi. At present photos can be taken only in dry or gas wells, but results have been very helpful in determining conditions such as attitude and orientation of fish, orientation and type of hydraulic fracture, success of cement jobs, hole configuration, and type of plugging agent on sand face. Film is 16 mm, and 1000 pictures can be taken on a single trip in the well. A light source surrounds the lens, and shots are taken from a surface signal. The camera rests on the low side of the borehole, and compass-oriented pictures permit the determination of direction of hole deviation and orientation of natural or derived fractures across the bore. The latter is invaluable for interpreting regional tectonics and forecasting structural trends. Examples of downhole photographs are given. Usable photos have not been obtained in liq-filled wells, but baling down to below the zone of interest enables satisfactory pictures to be taken. C. A. F.

265. Dual completion workover programme increases production. E. H. Furrey. *World Oil*, Oct 1960, **151** (5), 153.—Workover of dually completed Devonian and Clearfork wells in the Dollarhide field of W Texas has proved an economical operation, giving *ca* 359,720 brl of additional oil. Acid treatments have been replaced by sand–oil fracturing, and single tubing strings have been replaced by retrievable gas lift equipment. The field covers *ca* 6400 surface acres and produces from multi-pays, including dolomitic limestones and cherts. Details of completion methods, production history, and workover procedures are given. Workover is carried out using a double jack-knife rig, tubing and casing are treated with hot oil to remove paraffin wax, and tubing is then removed. A retrievable bridge plug is run and set above a permanent-type packer, and a γ-ray log is run for cementation. Additional zones are perforated and the well fractured down the casing using 45,000 gal of base crude, 45,000 lb of sand, and 10,000 gal of acid. Diagrams show three types of dual completion used in the Dollarhide field. C. A. F.

266. New perforators ease slim hole completion problems. P. DeFrank. *World Oil*, Oct 1960, **151** (51), 157.—The increase in slim hole drilling and the setting of small dia pipe has led to development of miniaturized perforating tools providing max penetration with minimum debris. Perforating problems due to slim hole operations are described, together with methods and tools designed to meet them. There are two basic types of gun: expendable and non-retrievable, and retrievable but expendable types. In the expendable and retrievable type the charges are hermetically sealed from well fluids and pressures, and are usually linked by a pin and box type connexion; blank interval bars are available to permit skipping of intervals. In the expendable and retrievable type the charges are enclosed in a hollow steel carrier which will withstand pressures exceeding 20,000 psi before perforating. Guns can be oriented by mechanical and radioactive methods. In the former the upper tubing strings carry an eccentric mandrel above each zone to be perforated, and a spring-loaded arm to orient with the mandrel is fitted on the gun. In the latter a focused ray source is fixed to the perforating gun and a detector is run in the adjacent string. The gun can be rotated until the signals indicate the correct position. C. A. F.

267. How to complete high pressure gas wells. W. D. Smith. *World Oil*, Nov 1960, **151** (6), 101.—Some gas wells in S Louisiana have pressures exceeding 6000 psi, and completion methods have been introduced for these wells in which concentric tubing strings are used. Standard practice is to fit 1¼-inch integral joint tubing inside the normal 2⅜-inch tubing string. The 1¼-inch kill string is run open-ended and hung

free in the larger tubing. The method has been successful in wells with surface tubing pressures up to 13,000 psi. It provides a safe solution to the problem of completion in high pressure gas wells, and there is provision for introducing corrosion inhibitor into the well bore. Details of the completion procedure are given, with diagrams and case histories of wells. A disadvantage is that bottom hole pressures cannot be obtained because of the small dia of the integral joint tubing. Abnormally high well pressures have been one of the major drilling and production problems in S Louisiana. Additional cost for this type of completion is $16,000–20,000. C. A. F.

268. In North Louisiana . . . small gas repressuring project is paying off. P. R. Waddle. *World Oil*, Sept 1960, **151** (4), 96.—A small gas repressuring project in the Rodessa field, Caddo Parish, Louisiana, has given an additional recovery of 1·2 million brl from 12 direct and second line offset wells over the period April 1940 to Nov 1959. This is a 109% increase over a primary recovery of 1·1 million brl. Only one well was used for repressuring, and 3·4 billion cu ft were injected.

The field produces from the upthrown side of the Rodessa fault, and the pay is in the Gloyd zone, consisting of lenses of sandstone and oolitic limestone at *ca* 6000 ft. Average pay thickness in the injection area is 16 ft, with porosity and permeability averaging 17% and 66 mD. Connate water is 20%. Production history is outlined. C. A. F.

269. How Gulf automated a 74-well lease in West Texas. C. E. Goldring. *World Oil*, Oct 1960, **151** (5), 139.—An automatic tank battery has been installed in W Texas which serves 74 producers. All operations are automatic for controlling oil flow from well to pipeline. Main features include the following automated procedure: (1) well testing for oil, gas, and water; (2) well test data print-out; (3) meter recording of gas production; (4) central battery treating system; (5) monitoring for bad oil production; (6) LACT; and (7) devices for allowable attainment. Details of the equipment are given with diagrams and photographs. C. A. F.

270. How new underwater oil storage unit works. R. Lacey and J. Estes. *World Oil*, Nov 1960, **151** (6), 92.—A mobile underwater oil storage unit has been completed for an area offshore from Louisiana. It has a capacity of 20,000 brl and is a self-contained submersible unit sunk in 35 ft of water adjacent to a well platform. It is designed to meet severe weather conditions, and the steel storage tanks are fitted with cathodic protection, and they are safe from rupture and the effects of marine growths. Details of the unit are given, and it consists of production compressors, pump, and quarters platforms. It has an important potential use in major producing areas where a marine line to shore is uneconomical and could be regarded as a permanent installation for the life of the field. It offers adequate production facilities for deep water operations. C. A. F.

271. Emsland's petroleum deposits and their production problems. (In German.) D. Marsal. *Erdöl u. Kohle*, 1959, **12**, 407–22.—The Emsland area in NW Germany, near the Dutch border, has seven oilfields and six gas fields, all discovered between 1938 and 1958. The gas fields are imbedded in Permian dolomites; the oilfields belong to the Lower Cretaceous or Upper Jurassic formations. The reservoirs are exploited by eight companies which, by 1958 end, had recovered cumulatively 9·3 million tons of crude oil and 1200 million m^3 of natural gas. The greater part of the crude is produced by natural water drive, in the Lingen–Dalum field by dissolved gas drive. Approx 10% of the oil-in-place in reservoirs connected with aquifers can be recovered by edge water expansion. The most important oilfield in Emsland (and in Germany) is Rühlemoor, belonging to the Rühle anticline, with a production rate of approx 40,000 tons/month. Pressure in this field is ensured by water injection into wells located in the aquifer near the original oil/water contact. A 60-years flank injection programme is being planned for the second largest oilfield of Emsland, Georgsdorf. A pilot test was started one year ago to confirm the results of theoretical studies for this secondary project. The main reservoir engineering problems of the Emsland oilfields originate from the heterogeneity of the oil-bearing formations and—at least at Rühlemoor—channels with possibility of still higher permeabilities forming a net, and prohibiting water injection into the pay, from the high visc and insufficiency of natural water drive. Pt 2 contains a detailed description of these and other problems, a discussion of production difficulties, and the most important data required for reservoir engineering studies. Six refs. R. T.

OILFIELD DEVELOPMENT

272. Home markets offer growing outlet for Texas–Louisiana gas reserves. R. L. Conkling. *World Oil*, Oct 1960, **151** (5), 145.—The level of discovery of gas reserves in Texas and Louisiana will fail to meet growing demands during the next five years, and it is estimated that in 1964 the annual level of reserves will have to increase by *ca* 38% to meet local and interstate gas markets. The problem of gas reserves in relation to market requirements is discussed with charts and diagrams, and it is concluded that there is an urgent necessity for accelerating exploration and development by providing adequate producer incentives. This will require the bringing of increased capital into the oil industry, and this would be stimulated by prospective earnings which were sufficiently attractive to compete successfully in the financial market. C. A. F.

273. Deep gas search sparks S Texas exploration. R. I. Jindra. *World Oil*, Nov 1960, **151** (6), 97.—Careful selection of deep prospects should increase discovery rate of gas-condensate fields in S Texas. There is active exploration in the area, particularly along the Edwards and Wilcox trends. Little drilling has been done recently along the Frio–Vicksburg trend. Developments and prospects for this region are discussed by Railroad Commission districts 1, 2, and 4. In No. 1 production comes from Ellenburger limestone through to Miocene Oakville sands, and in No. 2 from the Edwards limestone to the Oakville. In No. 4 there is active development of Wilcox and other production. Production trends are moving SW into the Rio Grande Embayment. A map shows distribution of main fields in the region. C. A. F.

274. Southeastern wildcats seek the answer. F. J. Gardner. *Oil Gas J.*, 21.11.60, **58** (47), 261.—The successful discovery of Lower Cretaceous oilfields in S Mississippi in recent months has stimulated the search for similar fields between the Citronelle area in Alabama and Summerland in S Florida. Any reservoir will be deep, and so far three dry holes have been drilled and four wildcats are under way. Details of these are given. C. A. F.

275. Linton, Berea, and Cambrian are principal targets of Ohio drillers. W. L. Calvert. *Oil Gas J.*, 24.10.60, **58** (43), 168.—Active drilling is still under way in Ohio, where 639 wells were drilled during the first eight months of 1960. 259 of these were completed for oil production, averaging 45 bd/well. 167 were completed as gas wells, with an average initial open flow of 1647 Mcfd. Completion success is approx 67%. Statistics of exploratory drilling in Ohio are given in tables. Important developments include gas strikes in the Mississippian and Devonian. No important shallow Pennsylvanian fields are reported. Water flooding projects are active. C. A. F.

276. California offshore oil search may pay off. Anon. *Oil Gas J.*, 3.10.60, **58** (40), 144.—A successful offshore well is reported from California, where drilling is being carried out offshore from Gaviota in 95 ft of water and has been carried below 2000 ft. Earlier reports indicated successful wells from a floating drill ship. Several operators are drilling offshore in the area, but little accurate information is available; other discoveries are reported. C. A. F.

277. Here's an area that rates extravagant claims. F. J. Gardner. *Oil Gas J.*, 28.11.60, **58** (48), 111.—In the past three years the Swan Hills region of Alberta has become one of the largest producing areas of W Canada. The field is now the third largest in Canada and may prove to be the largest. Present rating is: (1) Redwater, (2) Pembina, (3) Swan Hills. The field was discovered in 1957 in a reef complex of Beaverhill Lake–Devonian age. Productive area is still undefined, and there are satellite reservoirs at Virginia Hills, Judy Creek, and W Judy Creek. Reserves at Swan Hills have been estimated at up to 500 million brl, and Judy Creek and W Judy Creek at 112,500,000 brl and 20 million brl respectively. Virginia Hills is 10 miles W of Swan Hills, and new estimates are a min of 101 million brl, giving a total of 733,500,000 brl for the whole Swan Hills region. C. A. F.

TRANSPORT AND STORAGE

278. Tanker cleaning berth at Birkenhead. Anon. *Engineer, Lond.*, 1960, **210**, 901.—Service provided to enable shipowners to comply with Oil in Navigable Waters Act, 1955, also for gas freeing and tank cleaning. Jetty (tankers up to 70,000 tons), oily water pumped to two Dorr–Oliver separators (900 tons/hr), oil after stripping off light fractions used as boiler fuel. V. B.

279. Handling and transportation of heavy organic chemicals. I. General considerations. C. D. Callieu. *Chem. & Ind.*, 1960, 1344–7.—Advantages of bulk over packaged delivery are stressed; former may be applicable to relatively small quantities. Types of bulk container in current use and possible future designs are considered. Use of operational research is illustrated by consideration of two distribution problems. **II. Technical problems.** J. W. Fletcher. *Ibid.*, 1348–53.—Technical problems of bulk handling of org liq include fire, explosion and toxic hazards, risk of contamination, and choice of suitable construction materials for containers. Fire and explosion hazards are considered in relation to transport of C_4H_6, C_3H_4, $(CH_2)_2O$, and amines. Transport of acrylonitrile involves toxic hazards. Contamination problems occur with phenol and plasticizer alcohols, and choice of construction materials is important here. Flexible containers (Dracones and Portolite tanks) and their uses are described. W. A. M.

280. Gas hydrates: a practical control method. Pt 2. L. E. Connealy. *Oil Gas J.*, 17.10.60, **58** (42), 130–8.—Methanol injection is perhaps the commonest method of preventing hydrates in wet-gas systems and Texas Eastern's experiences are outlined. Methanol is injected at measuring stations on laterals, principally at the meter runs. On some laterals it is necessary to inject additional methanol at points along the lateral, the methanol travelling with the gas stream, thus preventing freezing in the main line. Facilities for injection must also be provided at compressor stations because hydrate formation can be accelerated by turbulence caused by station suction. Methanol injection also takes care of the freezing of meters. The need for preplanning in combating hydrate formation is emphasized, and it is suggested that methanol injection should start as soon as the ground temp reaches a preset min. Although some alcohol may be wasted by beginning injection before hydrate formation, the loss should be small, compared to the increased ease of operation. A. D. S.

281. World's second biggest gas field seeks a market. E. Rerolle. *Oil Gas J.*, 31.10.60, **58** (44), 92.—It is estimated that the Hassi R' Mel natural gas field in Algeria will produce at a rate of 20 billion cu m pa for 50 years. Several solutions for getting this gas to Europe are considered, which include the interest of two companies in transporting liq methane at very low temp and a number of schemes for transporting the gas direct to Europe by pipeline. A. D. S.

282. What's involved in European importation of liquid methane. Anon. *Oil Gas J.*, 31.10.60, **58** (44), 138–9.—Importation of liq methane into Europe involves a number of problems, including legal, safety factors, economics, political, and customs duties. These are briefly considered, and it is concluded that none appears to offer a serious setback to this project. A. D. S.

283. Pipelines play key role in European growth. G. Kinney. *Oil Gas J.*, 31.10.60, **58** (44), 88–91.—Pipelines will be the dominant means of transporting crude oil to inland refineries of W Europe by 1963. The first major crude line did not start operating until 1959 and is the 230-mile 28-inch NW line from Wilhelmshaven to Cologne. In 1959 it carried 106,000 bd crude oil, but by end of 1960 throughput will increase to 180,000 bd. The 183-mile, 24-inch Rotterdam–Ruhr line has just gone into operation, and initial capacity is 180,000 bd, increasing to 200,000 bd by 1963.

The S European pipeline, a 419-mile, 30-inch system from Lavera to Strasbourg, is scheduled to open in 1963 with an initial capacity of 200,000 bd. An Italian–Swiss venture proposes to build a 250-mile, 24-inch line from Genoa to Aigle, and in Russia a 2800-mile large dia line is projected to transport crude from oilfields E of the Volga to Poland and E Germany.

Several natural gas pipelines, including those designed to open up the vast reserves of the Sahara, are discussed. The French hope ultimately to ship Saharan gas to Europe, either by pipeline across the Mediterranean or as liquefied methane by tanker. A. D. S.

284. New plastic pipe passes field and lab tests. J. C. Lehr and R. B. Orr. *Oil Gas J.*, 17.10.60, **58** (42), 89–91.—Delrin acetal resin has both high strength and toughness values and shows outstanding fatigue endured under pressure–surging conditions. It is resistant to solvents, outdoor weather, and underground burial, is dimensionally stable, and retains its excellent properties over a wide temp range. A comprehensive lab test programme is under way to obtain long-term design-strength data on this new product, and already a 2-inch, 100-ml wall Delrin resin pipe is being marketed. A. D. S.

285. An automatic control system for a compressor station. K. S. Magins and L. R. Henry. *Pipe Line News*, Oct 1960, **32** (10), 56.—This paper summarizes studies leading to the decision by Colorado Inter-state Gas Co to install an automatic control system at their gas pipeline at Springfield compressor station. This station is a main line booster which pumps gas from Texas, Oklahoma, and Kansas supply areas into the Rocky Mountain market areas. The compressor equipment, installed in 1953, consists of four gas engine–compressor units each rated at 1192 hp. The nominal station design conditions are 840 psia discharge, 500 psia suction, and a compressed vol of 185 million scf/day. A simplified diagram and brief description of the station control system, including the telemetering and logic equipment, are given in the paper. M. F. M.

REFINERY OPERATIONS

REFINERIES AND AUXILIARY REFINERY PLANT

286. Report on refinery maintenance. H. C. Bozeman. *Oil Gas J.*, 24.10.60, **58** (43), 85–103.—With the demand for more efficient maintenance, a number of factors receiving particular attention are discussed. These are the development of organizations that better cope with planning and scheduling, the training of maintenance men, on-stream inspection, and safety, plant upkeep, and emergency planning.

Two broad organization trends are emerging, one to more central supervision and planning, which is being adopted by the small refinery with less than 100,000 bd capacity, and the other to decentralized supervision and central planning, which is being followed by the larger refineries. These different trends in maintenance organization are fully discussed.

Training in refinery maintenance is taking on a new significance. Some of the forms of training which are being conducted are craft-appreciation training, advanced training, supervisors' training, special short courses dealing with new techniques or equipment, off-duty training, and apprentice-training.

The scope of maintenance activities has broadened appreciably in recent years. In on-stream inspection, ultrasonics, radiography, corrosion probes, and temp indicating points are some of the tools now being employed. On-stream maintenance now contributes to longer runs, and two examples are given for heat exchanger cleaning. Off-stream maintenance is using such tools as chemical cleaning, corrosion inhibitors, better construction materials, and photography.

Maintenance costs are briefly discussed, and examples are given showing changes in cost annually from 1955 to 1959 for several refinery units. The costs are shown as per cent of replacement value and are composed of direct maintenance, supplies used by maintenance department, and warehouse costs. The costs fall into a band, the width of which is influenced by corrosion, erosion, temp, pressure, size, and cost of plant. A. D. S.

287. Treating aromatic by-product light oils from pyrolytic conversions by the BASF–Scholven process for light oil refining. (In German.) O. Reitz. *Erdöl u. Kohle*, 1959, **12**, 339–44.—Refining of light oils or crude benzol by H_2SO_4 has been replaced largely in Germany by cat pressure refining, using H_2-containing gases, by the BASF–Scholven process. Yield and quality of the refined products are much higher. The highly S-free products required by the chem industry can be obtained only by hydrogenation. In the U.S.A. the process is used for refining the BTX fraction of crude light oil. Pressure-refined BTX contains $<$ 1 ppm thiophene; pure aromatics from Udex-extraction equal in quality those obtained from petroleum. The process is applicable also to refining aromatic gasolines—by-products from oil gasification—for producing unsaturated hydrocarbons from crudes, or from petroleum fractions, and for producing fuel gas or town gas from these raw materials. Aromatics remain unaltered in the hydrogenation process; the olefins can be saturated completely or partially as required. Refinery gases, ammonia-synthesis gas, coke-oven gas, or similar H_2-containing gases may be used. With H_2 pressures up to 25 atm are used, with other H_2-containing gases pressures up to 50 atm are necessary. Pure aromatics of high quality can be obtained by extraction or azeotropic dist, and the product can be used as motor gasoline. Not only the refining of oil gasification light oils alone, but refining in mixtures with crude light oil for pure aromatic production from the refined product, is in use currently in tech plants. 15 refs. R. T.

288. Photography is a good maintenance tool, too. C. B. Hammond. *Oil Gas J.*, 7.11.60, **58** (45), 147–8.—Principal uses for photography in plant maintenance are to reduce the amount of drafting work and to provide better information for supervisor and craftsman. The polaroid camera, because of low initial cost, easy operation, and quick results, is a useful tool. Application to minor and major repair work and to new installations is considered. A. D. S.

289. The BP Ruhr refinery. E. R. Hill. *Petrol. Times*, 21.10.60, **64**, 717–22.—The new 100,000-bd BP refinery at Dinslaken is on stream, producing a wide variety of petroleum products, including fuel and heating oils, diesel and LPG fuels, petrol, aviation turbine gasoline, and jet fuels.

The major process units now in operation consist of two 50,000-bd crude dist units, a 12,500-bd cat reforming unit, a 10,000-bd gas oil Hydrofiner, a gas recovery plant, a 10,000-bd re-dist unit, and two copper chloride sweetening units. Scheduled for operation next summer as part of a planned expansion are a 10,000-bd cat cracking unit, a vacuum unit, a 100,000-tons/pa bitumen plant, and an additional copper chloride sweetening unit. A. D. S.

290. The West German refinery expansion. Anon. *Petrol. Times*, 21.10.60, **64**, 711–16.—Two factors dominated the W Germany refinery expansion programme up to *ca* 1955. These were that Germany already possessed a refinery industry and that the consumption pattern was very heavily weighted towards motor spirit and diesel oil. The necessary expansion of crude capacity was mainly achieved by adding to existing small installations, which led to the existence of a number of small refineries. Very considerable expansion has also taken place in capacity of plants designed to increase yield and improve the quality of light fractions.

At the beginning of 1956 refinery capacity was just capable of dealing with demand. Consequently, to keep ahead a more rapid stage of expansion was needed, and four new refineries were constructed in the Ruhr area and one in Emden. Additionally, two large oil pipelines were constructed to bring crude from the North Sea coast into the Ruhr.

Although, at present, capacity is well ahead of consumption, further refineries are in the construction or planning stage which will extend the refinery network into the S. A. D. S.

291. Milford Haven oil refinery. Anon. *Engineer, Lond.*, 1960, **210**, 828–30; *Fluid Handl.*, 1960, 309–14.—Illustr description. Crude storage $1{\cdot}5 \times 10^6$ brl, oil flows through pipe still (465×10^6 Btu/hr) to 100,000 bd atm dist unit (9×211 ft). Overhead light ends, three steam-stripped sidestreams (jet fuel, gas oil, hy gas oil), and residue. Light ends separated into gas, light naphtha (Cu sweetened), hy naphtha (hydrofined then cat reformed). Jet fuel also Cu sweetened, gas oil hydrofined. Air cooling throughout. Flare stack eliminated in favour of low multi-burner non-luminous smokeless flare. Anti-pollution measures include 300-ft stacks. Total tankage 19×10^7 gal. V. B.

292. Problems of refinery construction in Central Europe. (In German.) B. Riediger. *Erdöl u. Kohle*, 1959, **12**, 431–40.—After the destruction of world war II, refineries in Central Europe, formerly near the coast, for processing imported crudes, have been reconstructed and enlarged. Hydrogenation plants built near coal mines proved the exception. These plants, reconstructed and readjusted for crude processing—also to be fed by pipelines—have been erected or are about to be completed during 1959 or 1960 in the interior of Central Europe. Increase of refinery throughput and development

and application of new processing methods to meet growing severity of requirements are discussed. Europe is participating in pioneering work done in N America in this field. Industry should help to solve problems of higher economy development, *i.e.* higher ON to allow higher CR. Hydrogenation processes are fostered. Jet and diesel fuel problems are simplified by reason of H_2 surplus from reforming plants, which fosters application of hydrogenation processes. Low-cost ash removal—difficult to accomplish—would be essential for their use in gas turbines. Considering the actual situation with emphasis on production, it must be kept in mind that future average demand in Central Europe will probably differ from the pattern of dist and residua cont in crudes; therefore means must be used to bridge this gap. Hydrogenation in the plants available is one of the means, but its importance is declining due to increasing capacity of other refineries. Under sp circumstances Houdresid may alleviate the situation. Feed preparation by solvent extraction may gain cracker feed and reduce residue output. Gasification for converting residua into val products may soon be an important refinery tool. 36 refs. R. T.

293. Esso's new Rotterdam refinery is completely air cooled. D. H. Stormont. *Oil Gas J.*, 31.10.60, **58** (44), 123–6.—This 100,000-brl refinery was built on a site filled 15 ft above sea level and its processing facilities include a 100,000-brl crude unit, a 16,500-brl cyclic Powerformer, a 16,500-brl gas oil Hydrofiner, and copper chloride treatment plant. Bulk of crude supplies are received by tanker from the Middle East, so that *ca* 2 million brl crude storage is provided. Modern features include a central control room for the crude unit, cat reformer, and hydrodesulphurization unit; complete use of electronic controls; remote tank gauging and temp measurement and wide use of in-line blending. Air cooling is used throughout the refinery except for jacket water cooling on compressors. A. D. S.

294. European petrochemical capacity is zooming. Anon. *Oil Gas J.*, 31.10.60, **58** (44), 99–100.—Leading the race of petrochemical production are such established chemical manufacturing countries as the U.K., Germany, France, and Italy. Other countries, such as Greece and Denmark, are turning to this industry on a large scale for the first time.

A summary is given of some of the more important construction projects under way or recently announced in European countries outside the Soviet orbit. A. D. S.

DISTILLATION

295. McCabe–Thiele diagram for the ideal cascade. A. J. Surowiec. *Industr. Engng Chem.*, 1960, **52**, 789.—The reflux-stage number diagrams used for representing the "tapered" plant employed in difficult separations are of little utility. A geometrical construction of the McCabe–Thiele type has been developed which satisfies the fundamental properties of the ideal cascade encountered in isotopic separations.

A useful diagrammatic means is thus available for analysing separation systems which use twice the min number of theoretical stages. The diagram provides an argument for induced reflux in the enriching section of the dist column. M. F. M.

SOLVENT EXTRACTION AND DEWAXING

296. Liquid–liquid extraction between concentric cylinders. M. W. Davis, Jr, and E. J. Weber. *Industr. Engng Chem.*, 1960, **25**, 929.—A rotary extractor has been used to study solvent extraction processes, and particularly the effect of stage residence time on the extraction of metallic ions such as fission products. This study extends the theories on Taylor vortexes to two-phase flow. The aq phase used was 5M nitric acid containing 0·0042M uranyl nitrate and the organic phase 2·5% by vol of tributyl phosphate in Ultrasene. The following results were obtained. The dispersed phase was not blended into vortexes until rotor speeds were well above critical speed for vortex formation. Mass transfer did not become efficient until this blending occurred. The behaviour of the aq and organic-dispersed systems differed fundamentally. HETS (organic dispersed) depended primarily on rotor speed and was independent of the flow rate. HETS (aq phase) increased with increased flow rate at low rotor speeds. Residence times were as low as 5–10 sec and HETS as small as 6–8 cm. M. F. M.

CRACKING

297. Cracking of gaseous hydrocarbons by partial oxidation. (In German.) E. Bartholomé and H. Nonnenmacher. *Erdöl u. Kohle*, 1959, **12**, 359–64.—In production and processing of crude oil, large quantities of gaseous or low-bp hydrocarbons are produced, chiefly paraffinic, generally usable only as fuels. By converting paraffinic gases into materials of higher activity, petroleum products can be converted into raw materials for chem synthesis and form the basis of large industries. Three methods are available for this conversion, represented by eqn:

$$2CH_4 = C_2H_2 + 3H_2 - 86{\cdot}3 \text{ kcal}$$
$$C_2H_6 = C_2H_4 + H_2 - 31{\cdot}0 \text{ kcal}$$
$$CH_4 + H_2O = CO + 3H_2 - 45{\cdot}8 \text{ kcal}$$

Partial oxidn is effective for heat supply in endothermic cracking reactions. The method is illustrated by homogeneous cracking with controlled quenching for C_2H_2 production. Since the report to the 4th World Petroleum Congress, burner size has been increased to 14 metric tons C_2H_2/day. Other hydrocarbons investigated as feed are from diluted CH_4 to light naphtha. A further illustration is heterogeneous cracking on solid materials for olefin production. Gaseous hydrocarbons premixed with O_2 can be cracked on inert solid materials in an autothermic process for olefin production. The process allows deep cracking per pass, and is very flexible as regards feed. A plant is in operation at Ludwigshafen. Gaseous hydrocarbons can be converted into synthesis gas by adding O_2 in a flame reaction at the point where hydrocarbon and O_2 meet, followed by a cat reaction. The partial oxidn also can be performed in a flameless cat reaction of the O_2–hydrocarbon mixture. By this method any gaseous or evaporated hydrocarbons—CH_4 or higher homologues—may be used as feed without soot formation. For both methods units are in operation, each producing synthesis gas for more than 100 tons of N_2/day. 16 refs. R. T.

298. Catalytic hydrocracking of aliphatic hydrocarbons. R. C. Archibald *et al. Industr. Engng Chem.*, 1960, **52**, 745.—Hydrocracking of hydrocarbons to produce gasoline from heavier dist derived from coal has been a major European chemical process. The work reported in this paper was initiated to assess scientifically its application to dist derived from petroleum and to compare the results with those from conventional cat cracking, in terms of the reaction of aliphatic hydrocarbons.

The results show that hydrocracking of aliphatics follows the carbonium ion mechanism of cat cracking with hydrogenation superimposed. Differences in selectivity are attributable in large degree to the lower temp used for hydrocracking. M. F. M.

299. Fundamental relations in the pyrolysis of hydrocarbons to acetylene and ethylene. (In German.) H. Krekeler, R. Wirtz, and N. Pechtold. *Erdöl u. Kohle*, 1959, **12**, 353–8.—During the last few years Farbwerke Hoechst AG has built petrochemical plants for thermally cracking hydrocarbons of

different mol wt to lower-mol wt olefins. Experiments in a high-temp pilot cracking unit to determine the effects of cracking temp and feedstock composition are reported. For a given feedstock, composition and product gas yield are dependent primarily on final cracking temp. Results are independent practically of temp of combustion gases from the burner provided that this temp is not much $>$ *ca* 2300° C. At temp $>$2300° C the C_2 cont of product decreases. Energy input to the system, however, is influenced strongly by burner gas temp and increases rapidly with decrease in burner temp. The range of the straight-chain hydrocarbons gives the best C_2-gas yield. Max C_2-gas yields are obtained with feedstock chain length C_7–C_{10}. Shorter chain lengths give increased CH_4 yield at the expense of C_2 gases; longer chain lengths produce more tars and $>C_4$ hydrocarbons. Branched chain feedstocks yield less C_2H_2 and much less C_2H_4 than straight chain, also more unsaturated by-products and CH_4 than do *n*-paraffins containing the same number of CH_2-groups. Naphthenic feeds give satisfactory C_2H_4 yields and high tar quantities. Aromatic cpds give much tar and little cracked gas products. Olefins require relatively little cracking energy, produce less C_2 gases and more by-products than the paraffins. Feedstock composition, therefore, assumes greater importance when emphasizing high C_2H_4/C_2 product gas ratios. With a known qual and quant feedstock analysis, cracking yields may be computed fairly accurately from results obtained in this investigation. Six refs. R. T.

300. Catalysts on the basis of acid-activated bentonite. (In German.) W. Franz, P. Günther, and C. E. Hofstadt. *Erdöl u. Kohle*, 1959, **12**, 335–9.—Montmorillonite-type naturally occurring alumino-silicates are generally termed bentonite. Bentonites are valuable commercial substances used for decolorizing oils, bonding moulding sands, and in oil well drilling muds. More recent application is as cat for acid catalysed reactions. Montmorillonite is characterized by three-layer-sheets, two layers of silica in tetrahedral coordination, and one layer of aluminium in octahedral coordination with O_2 and OH in the anion position. Montmorillonite mineral has a large surface and possesses the property of ion exchange. Theories of the unique chem behaviour of montmorillonites and cat properties of various cat produced by cold or hot acid treatment are discussed. Cold acid treatment leads to substitution of exchangeable cations by H-ions, forming strongly acidic hydrogen bentonites. As alkylation or isomerization cat they are employed up to 200° C. Cat produced by hot acid treatment can withstand high temp, *e.g.* in hydrocarbon cracking. By a new theory the authors postulate that montmorillonite activation by hot acid leads to formation of acidic SiO_2–Al_2O_3 surface by migration of Al-ions to the surface. Simultaneously, exchangeable alkali ions, freed by hydrolysis, are removed. Spherical montmorillonite cracking cat are produced in Germany Fe-free, of high cracking activity and hardness. Acid montmorillonite cat of the hydrogen bentonite type can be produced with sp properties, acidity, active surface, adjusted to sp use. 13 refs. R. T.

301. Manufacture and use of some catalysts in the petroleum and petrochemical industries. Cobalt molybdenum desulphurization catalyst. E. B. Andrews. *Chem. & Ind.*, 1960, 1396–400.—Review of uses of alumina-supported cobalt–molybdenum cat (2–4% CoO, 8–15% MoO_3) for hydrodesulphurization of petroleum fractions is followed by accounts of manufacturing methods and quality control. 40 refs. **Silica–alumina cracking catalyst.** S. Gabriel. *Ibid.*, 1401–9.—Brief review of cat cracking is followed by a detailed account of the manufacture, quality control, and performance assessment of synthetic silica–alumina (13% or 25% Al_2O_3) fluid cracking cat. Nine refs. **Catalysts used in the manufacture of ammonia.** D. J. Borgars and G. W. Bridger. *Ibid.*, 1426–32.—Synthesis of NH_3 from natural or refinery gas involves the following cat processes: (1) desulphurization by cat 32–2 (yellow), which is 95% ZnO; (2) steam reforming over cat 22–1 (green), an activated Ni cat containing approx 14% Ni in the reduced state; (3) secondary reforming over the same cat as in (2); (4) shift conversion over cat 15–2 (brown), mainly Fe_2O_3 promoted with Cr_2O_3; under operating conditions the stable form is Fe_3O_4; (5) methanation over cat 11–1 (African), a NiO–Cr_2O_3 cat, guarded by cat 29–1 (peat), which is reduced CuO–ZnO and hydrogenates harmful S cpds; (6) NH_3 synthesis over cat 34–4 (ebony), which consists of Fe doubly promoted with an alkali such as K and an amphoteric oxide such as Al_2O_3 or SiO_2; an alk earth promoter may be added. Kinetics of reactions taking place on these cat and effects of poisons are considered. 12 refs. W. A. M.

ALKYLATION

302. Alkylation of aromatics with 1-alkenes. A. C. Olson. *Industr. Engng Chem.*, 1960, **52**, 833.—Because the surface-active properties of alkylbenzene sulphonates vary with structure, a study of the isomers obtained from alkylation of aromatics with 1-alkenes was made. Mixtures of secondary monoarylalkanes are formed in the alkylation of benzene, toluene, and *m*-xylene with 1-alkenes in the presence of strong acid cat.

Arylalkane mixtures from the same olefin are different in hydrofluoric acid, sulphuric acid, and aluminium chloride cat. Isomerization occurs before arylalkane formation with the first two cat, but with aluminium chloride at least part of the isomerization occurs after initial formation of 2-arylalkane. M. F. M.

SPECIAL PROCESSES

303. Purifying olefins by catalytic dehydrogenation. H. C. Anderson, A. J. Haley, and W. Egbert. *Industr. Engng Chem.*, 1960, **25**, 901.—Ethylene, propylene, and other gas streams contain acetylenes and dienes which must be removed to make these gases usable for various processes. The acetylenes and propadiene are reduced to 10 ppm or lower by hydrogenation over cat consisting of supported palladium or palladium in combination with other metals. For purifying ethylene streams containing up to 2% C_2H_2, cat are available which operate at a hydrogen to acetylene ratio of 3:1 and the space velocity of 4500 scf/hr/cu ft. A similar range of conditions applies to methylacetylene and propadiene from propylene.

Experimental examples are shown for the purification of ethylene, propylene, methanol synthesis gas, and coke oven gas. Full-scale commercial plants in each of these categories are now operating with palladium metal cat. M. F. M.

304. Petrochemical carbon disulphide from methane. P. W. Sherwood. *World Petrol.*, June 1960, **31** (6), 62.—Carbon disulphide is conventionally produced by a high temp reaction between sulphur and charcoal which requires high capital investment, and in recent years the market for CS_2 has declined. Nevertheless, production capacity for this liq is being expanded in the petrochemical field. Sulphur is obtained by partial oxidn of H_2S recovered from sour gases, and natural gas serves as the other feedstock. CS_2 is synthesized from these components either directly, in which an endothermic reaction of CH_4 with S yields CS_2 and H_2S, or indirectly, in which CO derived from methane is reacted with S to yield CS_2 and CO_2. Design considerations are outlined. C. A. F.

305. The production and utilization of butadiene. A. A. Appleton. *J. Inst. Petrol.*, 1960, **46**, 367–73.—Commercial

processes for producing butadiene are considered and include the Aldol process, dehydrochlorination of dichlorobutane, *cyclo*hexane hydrolysis, the Reppe process, alcohol dehydration, butene and butane dehydrogenation, and cracking processes. Tabulated details are given of the distribution of these processes, showing that though dehydrogenation of butylenes is still the dominant process, the one-step Houdry process is making considerable strides. It is interesting that in Europe, as compared with the U.S.A., steam cracking is utilized to about the same extent as butylene dehydrogenation.

Extraction processes for purifying the crude butadiene, including cuprous ammonium acetate and furfural, are discussed. The main utilization of butadiene is in the field of synthetic rubbers and production of SBR, N-type rubber, and polybutadiene rubber is considered. The only other sizeable requirement of butadiene is for making adiponitrile for nylon.

A. D. S.

306. U.S.–European technology combine to make butadiene from methane. J. C. Reidel. *Oil Gas J.*, 31.10.60, **58** (44), 94–7.—The discovery in Italy of natural gas, which was nearly pure methane, in an area so close to the Adriatic Sea, led to a new concept of processing for manufacture of synthetic rubber and nitrogenous fertilizers. The process scheme of the large ANIC petrochemical complex is shown. The plant consists of a Linde cold box for low-temp fractionation of air; the main organic section, where methane is partially oxidized to acetylene, which after purification is converted to acetaldehyde and thence to butadiene by the Carbide process; the new butane dehydro-furfural extraction section for butadiene; and an inorganic section comprising hydrogen purification, ammonia synthesis, and fertilizer manufacture. Styrene is also manufactured by reacting ethylene and benzene and dehydrogenating the resultant ethylbenzene. The latest addition to the fertilizer section is a urea plant using the Netherlands Staatsminen process.

A. D. S.

307. The manufacture of ethylene oxide. R. P. van Oosten. *J. Inst. Petrol.*, 1960, **46**, 347–51.—Two processes are almost exclusively used for the production of ethylene oxide—the chlorohydrin process converting ethylene into ethylene chlorohydrin by means of hypochlorous acid, followed by dehydrochlorination to give ethylene, and the direct oxidn process which converts ethylene to its oxide in one step by means of reaction with air or oxygen over a silver cat. There appears to be a distinct preference for the direct oxidn process, mainly because it does not give rise to by-products, does not require chlorine, and can now be simply carried out due to rapid developments in chemical engineering since the war.

The salient features of the different versions of these processes are detailed, and flow diagrams are presented.

A. D. S.

308. Economics of ethylene production from light naphtha. J. Chrones and J. L. James. *J. Inst. Petrol.*, 1960, **46**, 337–45.—In examining the economics of ethylene production from light naphtha, three main factors stand out as having important effects on costs. These are: production distribution, plant size and value of fuel, feed and by-products. Three cases are examined in order to cover a wide range of typical product distributions from a high through an intermediate to a low value of ethylene/by-products yield ratio.

It is concluded that the cost of the feed naphtha and the value credited for by-products are the biggest factors affecting the economics. High severity operation, with recycle ethane pyrolysis to minimize feed consumption, is favoured under conditions of high naphtha feed costs and relatively low by-product values. Conversely, lower severity operation without recycle ethane pyrolysis would be preferred when naphtha feed cost is low or by-product values high. At present the ethylene market is considerably greater than that for other by-products. Thus a high ratio of propylene to ethylene in pyrolysis cannot be justified on the present basis of its potential for polypropylene.

It is recommended that producers should carefully consider ethylene recovery capacity considerably larger than material requirements, because of the increasing ethylene market.

A. D. S.

309. Twenty-five years of Fischer–Tropsch synthesis with fixed-bed catalysts. Present position and future possibilities. (In German.) H. Tramm. *Erdöl u. Kohle*, 1959, **12**, 347–53.—Fischer and Tropsch succeeded in producing liq hydrocarbons 34 years ago from CO and H_2 according to the eqn $nCO + 2nH_2 = n(CH_2) + 2H_2O$. From 1936 to 1942 a large number of Fischer–Tropsch plants arose in Germany; particularly since 1946 has the fixed-bed synthesis progressed. The most modern plant in S Africa is equipped with reactors with an output capacity 25 times > that of the original reactors. The stoichiometrical possibilities of producing hydrocarbons from CO and H_2 is presented, and development of the highly efficient reactor is discussed. Influence of CO_2, steam, and S cpds on the synthesis process is demonstrated, and control of these influences described. A method for calculating max permissible thickness for cat bed is described. Cat service periods are increased twofold by extraction without interrupting the synthesis for regeneration. Cat consumption/kg of primary product is <5% of that in the original reactor types. Possibilities of producing motor fuels and lub oils, as well as the importance of Fischer–Tropsch products for the chem industry, are described. Econ conditions on which the process depends are illustrated with ref to several examples. 11 refs.

R. T.

310. Sulphur recovery from petroleum gases. R. A. Graff. *Oil Gas J.*, 17.10.60, **58** (42), 118–21.—The two main sources of H_2S are in natural gas and sulphur cpds in crude oil which are cracked during refining. Conversion of H_2S to S is usually carried out by partial oxidn methods—one, known as a free flame method, has disadvantages when CO_2 is present in the H_2S stream because of side reactions. Another method, which is relatively insensitive to impurities in the acid-gas stream, is known as the one-third to two-thirds process. In this process one-third of the stream is burned to SO_2, which is then recombined with the two-thirds stream. The gas then flows to a cat reactor where conversion to sulphur occurs. Cat activity is maintained at a high level and sulphur is produced only in the condenser. Design considerations, including the steam generator, cat reactor, sulphur condenser, and disposal of vent gas, are discussed. The process, dealing with the acid-gas feed preparation, control, product handling, and economics, is also considered.

A. D. S.

311. Stock-tank vapour-recovery system. R. C. McCutchan. *Oil Gas J.*, 24.10.60, **58** (43), 112–16.—With the widespread installation of LACT batteries and consolidation of field batteries for unit operations or for labour and maintenance savings, large quantities of rich stock-tank vapours have become available at convenient locations for recovery. A typical example of an installation for vapour recovery is given. The tank vapours are compressed and separated in a discharge scrubber. Gas from the scrubber and the lease separator then go to a gasoline plant. Types of compressor and compressor drive are fully discussed, and the economics of the process are evaluated.

A. D. S.

METERING AND CONTROL

312. Automatic vapour-pressure instrument controls addition of LPG and natural gasoline to crude lines. P. R. Scott. *Oil Gas J.*, 24.10.60, **58** (43), 108–10.—A vapour pressure recorder-controller has been used to continuously monitor the crude

stream and control the volatile injection rate of LPG and natural gasoline to maintain the vapour pressure at a pre-set value. This has eliminated problems caused by high vapour pressure slugs in pipelines produced either during unscheduled stoppages or slow-down in the crude flow, or because of inadvertently setting gasoline plant pumping rates too high. The flow diagram is presented and the installation and calibration of the instrument described. Experience in operation led to improvements, resulting in vapour pressure variations of less than $\pm 0{\cdot}3$ lb.

This instrument neither records the true nor RVP, but a linear correlation does exist between the value obtained and the RVP. A. D. S.

313. Let a digital computer run your alkylation plant. D. B. Brandon. *Industr. Engng Chem.*, 1960, **52**, 814.—Maintaining operating conditions of an existing production plant at or near optimum is a major task of the process control computer. When a predictive control system using a digital computer is employed, a set of mathematical equations, called control equations, must be entered into the computer to provide the basis for its computation.

A procedure for establishing the control equations is outlined in this paper for an alkylation plant, where the values of eight independent variables specify particular operating conditions. Two sets of eight variables are formulated, one reflecting material balance, the other chemical factors and control actions. These two sets of variables are interrelated and combined with the process objective fraction, constraints on the variables, and an optimization scheme to produce the control equations. Provision is made for specific coeff of the control equations to be modified automatically and thus create an adaptive control system. M. F. M.

314. Investigation of process variables in ethylene manufacture. H. Booker, J. W. Bray, and P. R. Mitchell. *Industr. Chem.*, 1960, **36**, 485–8.—Use of a data logger on a plant for olefin production by pyrolysis of naphtha enabled over 50,000 readings to be taken in ten days, plant conditions being varied according to a pre-arranged programme. A computer was used to evaluate the effects of process variables and select optimum conditions for different circumstances. A predicted 3% increase in C_2H_4 production has been realized in practice. W. A. M.

PRODUCTS

CHEMISTRY AND PHYSICS

315. Elementary processes of mass transfer in extraction, absorption, and distillation. (In German.) H. Kroepelin, H-G. Neumann, and E. Prott. *Erdöl u. Kohle*, 1959, **12**, 344–7.—In a study on individual droplets in liq/liq extraction, considerable transfer was observed already during droplet formation. Observations with sensitive schlieren methods show that droplets generally do not emit matter into the surrounding phase by diffusion but by sudden explosive eruptions. When the droplet absorbs matter from the surrounding phase the processes involved are likewise impulsive. Two physical effects suffice to explain all observations made so far; motion within the interface (tangential motion), and outward or inward deflections of the interface (normal motion). Motions of these two types are due to local reduction of interfacial tension in a limited region of an interface. If the interface be curved the same phenomenon occurs. Moreover, on a reduction of r the curvature of the interface must increase when interfacial tension is decreased. (σ = interfacial tension, r = radius of curvature.) Tangential motion in plane interfaces must give rise also to forces, and thus motion in a direction perpendicular to the interface. This may be illustrated by simple hydrodynamic considerations. Corresponding phenomena, sometimes pulsations, were observed in the liq surface in processes where vapours were absorbed by liq. Similarly, mass transfer is increased considerably in extraction, absorption, and dist processes. The forces involved are so large that individual droplets can be torn out of the interface between two immiscible liq phases. Spontaneous emulsification may be attributable to the same phenomenon. Eight refs. R. T.

316. Occurrence and nature of hydrocarbon detonations. R. B. Jacobs. *Proc. Amer. Petrol. Inst.*, 1959, **39** (3), 15–20.—A review of major disasters caused by hydrocarbon explosions indicates that detonative-type explosions have occurred more frequently in recent years than in the past. Factors promoting detonations are discussed, and the destructive potentials of detonative-type explosions are analysed. An examination of the factors promoting detonations suggests that if flammable mixtures are permitted to exist within large, modern refining units, detonations are more apt to occur than they were with older, smaller units. Experience, however, shows that old units and small equipment can be subject to detonation.

(Author's abstract.)

ANALYSIS AND TESTING

317. Gas chromatography. J. H. Knox. *Petrol. Times*, 18.11.60, **64**, 787–8.—This paper summarizes some of the major developments in gas chromatography since the work of James and Martin in 1952. Methods for detecting and measuring changes in composition of the gas emerging from the column are briefly described. These include the katharometer, which has a limiting sensitivity of 0·01% of trace constituents, and the argon excitation and flame ionization detectors, which are some 1000 times more sensitive than the katharometer.

During the next few years the quest will be for high-speed gas chromatography, which should result in a greater use of this technique for analysis of plant streams and even for automatic plant control. A. D. S.

GAS

318. French natural gas wells at Lacq. L. T. Minchin. *Chem. & Ind.*, 1960, 1178–81.—Description of production, treatment, and distribution of Lacq natural gas. The high H_2S content (15·2%) will make Lacq the world's largest S producer. Other products include LPG and gasoline. Effect of Lacq wells on economy of district is outlined. W. A. M.

ENGINE FUELS

319. Development and significance of German multi-fuel diesel engines. (In German.) R. von Eberan. *Erdöl u. Kohle*, 1959, **12**, 380–5.—Over the past decade, and even earlier, mep and CR of gasoline and—mutually—anti-knock properties (octane rating) of fuels have increased constantly, correlatively adapting one to another. However, ignition quality of diesel fuel has remained unchanged for years. The multi-fuel diesel engine is required now to operate on the widest range of hydrocarbons, specifically including high anti-knock gasolines. Ignition knock—often termed diesel pinking in Germany—occurs at the start of combustion, in the Otto cycle engine at the end. Ignition lag and low self-ignition of anti-knock gasoline produces an environment of rapid pressure increase and vibration in the normal diesel engine. Greatly retarded combustion results in thermal loss,

incomplete combustion, and exhaust smoke emission. Controlled combustion is the role of the multi-fuel engine. Four German firms have made major strides in developing multi-fuel engines. Four-stroke multi-fuel engines differ in cooling method; all operate on leaded or rich-aromatic-cont gasolines. Only slight substitutions in basic engine construction are necessary. Significance of temp regulation in multi-fuel operation is demonstrated by an example. Cyl size is important in cold starting. Operational tests indicate that gasoline and diesel fuel show little difference in power developed and fuel consumption. Mean fuel consumption val show greater eff of the multi-fuel engine compared with the gasoline engine. Viewing the variety of crude oil derivatives, the multi-fuel diesel engine offers prospects of a much broader, thus more economic, basis for the increasing fuel requirements in the transportation field. R. T.

320. Small testing stand for engine testing of jet fuels. (In German.) G. Spengler and H. Gemperlein. *Erdöl u. Kohle*, 1959, **12**, 393–6.—Development of a small-scale combustion chamber—a subsonic ram jet—for studying and determining reaction time and other fuel characteristics in an air flow on 0·2–2 kg fuel is reported. Tube length can be varied, and the thrust developed can be used as an integrating factor for determining combustion eff. In the investigation of fuels in the combustion chamber, relationship between fuel properties, *e.g.* boiling behaviour, cal val, mol structure—*cf* boundary lubrication—on the one hand, and the combustion behaviour, on the other hand, could be determined. At the same time comparative experiments with combustion chambers of conventional type show direct relationship in the course of the combustion with the test combustion chamber. On the basis of experience with this instrument it is considered that this technique gives rapid and sure information on the suitability and combustion chamber behaviour of fuels for jet propulsion. R. T.

GAS OIL AND FUEL OIL

321. Fuel oil injection in blast furnaces. Anon. *Engineer, Lond.*, 1960, **210**, 909–10.—Injection of light fuel oil (36 cS/20° C) increased output by *ca* 10% for oil consumption of *ca* 50 kg/ton of Fe produced. V. B.

322. Petroleum products survey No. 16 is study of burner-fuel oils 1960. Anon. *Fuel Oil & Oil Heat*, 1960, **19** (11), 60–1.—The U.S. Bureau of Mines have studied and compiled analytical results on samples of burner fuel oil, typical of their manufacture during the early part of 1960. Data on 415 samples were submitted to the Bureau by 44 petroleum refining companies. The report presents the analyses in detail in five general groups by grades of burner fuel oils, each group being sub-divided according to geographic marketing distribution. A. D. S.

LUBRICANTS

323. Development of EP oils for reduction gears on steam turbines and hydraulic torque converters. (In German.) H. L. Steinbach. *Erdöl u. Kohle*, 1959, **12**, 397–406.—Coupling with entirely different gear types, *e.g.* steam turbines and hydraulic torque converters, has given rise to sp lubricant requirements for post-war increased loading of reduction gears. Requirements were met by developing oils with improved and extended EP properties. The most important gear features—including cutting and surface finish—which influence lubrication are discussed. The paper deals with sp demands made by makers of steam turbines or hydraulic torque converters on the oil, which restrict selection of base oils. Structure of the oil plays an important role, *cf* mol wt, decisive in boundary lubrication. A compromise in selection of base oil is often necessary. Especially in view of low visc demanded, high tooth load makes use of EP additives essential. With additives, the base oil must retain its non-emulsifying and foam-depressing characteristics, behave satisfactorily against rubber sealing materials, and must be non-corrosive. Definite quantities of silicones improve foaming resistance. Suitability of EP additives is tested as described on special testing machines, and EP turbine oil and hydraulic oil development is described in detail. Subsequently the oils were used in highly-loaded turbine reduction gears and hydraulic torque converters for oxidn and EP performance. The process of gear manufacture, surface finish of tooth flanks, heat treatment, EP additive depletion, neut val, must be considered. Val of EP oils for the running-in of all types of highly-loaded gears is important. 20 refs. R. T.

324. Evaluation of gear oils under conditions of boundary lubrication. (In German.) G. R. Schultze, A. Bartel, and J. Moos. *Erdöl u Kohle*, 1959, **12**, 374–80.—This article is limited above all to gear oils for heavy ships' gears. This lubrication results generally under hydrodynamic conditions and no longer presents great problems. However, the influence of boundary lubrication is more pronounced in the operation of slow-running naval gears. This may cause heavy damage, especially if inaccuracies in manufacture are exaggerated by use of improper additive oils. The correct kind of additive—even with badly-machined gears—ensures good running without pitting of the pitch lines. Studying naval turbo-gears in operation and testing the additive oils used with an electronic tester shows that the additives form either stable boundary layers on the surfaces of the teeth, with consequent failure, or form intermediate unstable films, with guaranteed good operation. This has led to a detailed study of chemical lapping with corrosion-resistant additive oils. Also, formation and disappearance of the boundary layers and influences which come into play have been investigated. Org Cl_2 cpds as additives have given good results and have received special attention. Testing methods for previously-used gear oils are reported, and a new testing equipment is described which gives results under conditions of boundary lubrication approximating to practical service. With this apparatus, accurate measurements of undulation elimination by chem lapping is possible. Application range, accuracy, and limits of test procedure are reported from actual measurements. From the results conclusions can be drawn regarding proper composition of naval gear oils with ancillary information regarding running in of such gears. 15 refs. R. T.

BITUMEN, ASPHALT, AND TAR

325. Error sources in determining the softening point of bitumen by the ring-and-ball-method. (In German.) Anon. *Bitumen, Teere, Asphalte, Peche*, 1959, **10**, 168–70.—Effects of overheating in melting are discussed. The chief errors in the determination lie in sample preparation and irregular heating rate. Thermometer arrangement and bath preheating can give unimportant variations. R. T.

326. Adhesive power of bitumen binders. (In German. W. Riedel. *Bitumen, Teere, Asphalte, Peche*, 1959, **10**, 214–17.—Pt I. A binder which may conform to regulation may fail in practice through inadequate adhesive properties. Perfecting methods for estimating adhesive properties, chip-binding capacity, and fixing limit val and min requirements regarding these properties, is of considerable practical importance when new building materials are to be introduced. Various binder properties defined and discussed are: adhesion, cohesion, visc, and ductility. Resistance to water pen is important. Causes and effects of stresses taken up by binders are disclosed. Tar–bitumen mixtures in various ratios are taken as suitable for ductility and cleavage strength tests in relation to temp. Results are presented in charts. R. T.

327. Bitumen constitution. (In German.) K. A. Fischer and A. Schram. *Erdöl u. Kohle*, 1959, **12**, 368–74.—In investigating asphaltic bitumen, relationship between structural composition and properties is emphasized. Bitumen may be observed as a colloidal dispersion of so-called asphaltenes in a maltene oily medium. Assuming that the properties of such a system are influenced more by size and arrangement of the constituent particles than by details of chem structure, mol wt distribution was investigated extensively. A formula was derived for viscosimetric determination of mol wt of mineral oil and bitumen components of higher mol wt. By this formula the number of asphaltene mol in a bitumen aggregating under various conditions to form a micelle could be estimated. Data on structure and composition could be obtained by spectroscopic investigations in connexion with hydrogenation under mild conditions. Both oil portions and asphaltenes consist of mol of similar form, namely, of aromatic and naphthenic ring systems substituted strongly with paraffinic chains with multiple O_2-links, and in which highly condensed ring systems do not predominate. Naphthenic rings are present in a small degree. Examination of syn model bitumens showed the properties of various bitumens to be influenced primarily by the solvent power of the oil component, which also determines micelle size. Solvent power of the oil component may be characterized by its aromatic ring cont. 19 refs. R. T.

328. Acid emulsions in road building. (In German.) — Fries. *Bitumen, Teere, Asphalte, Peche*, 1959, **10**, 166.—Emulsification and disadvantages of alk emulsions are discussed. Acid emulsions have the advantage of affinity for both basic and acid stone components, set rapidly, and are independent of weather conditions and atm moisture. They are valuable for road surface repairs. R. T.

329. Mechanical stability testing of asphalt coverings. (In German.) K. Letters. *Bitumen, Teere, Asphalte, Peche*, 1959, **10**, 204–13.—A comprehensive abstract of a paper by D. C. Broome and A. Please from *J. Appl. Chem.*, 1958, **H8**, 121–35. The article contains a comparison of eight mechanical testing methods on 12 mixtures to BS 594. Eight refs. R. T.

SPECIAL HYDROCARBON PRODUCTS

330. Solvents for decorative and industrial alkyd-based coatings. L. M. Barakan. *Paint Technol.*, 1960, **27** (276), 22–4.—Most of the decorative paints nowadays are based on long-oil pentaerythritol alkyds, whose solubility in aliphatic hydrocarbons is excellent. White spirit dist, and special bp solvents are commonly used. Low-odour hydrocarbon solvents manufactured from *iso*-paraffins and olefins have an inferior solvent power, and solubilizing agents have to be added to the resin-solvent system.

Alkyd resins of *ca* 40% oil length are more soluble in aromatic hydrocarbons, such as xylene, polymethyl benzenes, and ethyl benzene. By correct choice of solvents it is possible to adjust the evaporation rate to the application. Although aromatic solvents are the most widely used in industrial surface coatings, additional solvents of a more polar nature are employed. These depend on the types of modifying resins used with the alkyds, and include *n*-butanol, butyl acetate, and diacetone alcohol.

Tabulated details are given of commercially available aromatic solvent blends and test methods, such as aniline point and the kauri-butanol number, for determining the solvent power of hydrocarbon solvent, are briefly considered. A. D. S.

331. Development of improved insulating oils. N. W. Furby and F. J. Hanly. *ASTM Bull.*, 1960, TP155–61.—Utility companies in U.S.A. rate characteristics of oil in service in following sequence of decreasing importance: elect strength, acidity, power factor, interfacial tension, colour. Sludge formation considered important by only 4% of questionees. Prediction of service life by accelerated lab aging test is difficult; 12 such generally accepted tests are tabulated. Full description given of California Research Transformer Oil Stability Test. Apparatus as ASTM D943–47, 300 g oil, 250° F, 3 l O_2/hr, 450 cm³ Cu (14 gauge wire), 112·5 cm³ Fe (medium Si transformer Fe). Determine acidity and visible sludge on samples (15 ml) withdrawn at 96 hr and subsequently every 24 hr to 240 hr, then 48 hourly to failure, which is defined as acidity of 1 or visible sludge. Results on numerous oils given, showing marked synergistic effect of multiple inhibitors, *e.g.* organic selenides and/or quinizarin (metal deactivator) added to di*tert*-butyl-*p*-cresol (DBPC). Best result (test life *ca* 700 hr) obtained with highly refined (unsulphonated residue 98%) base oil containing 0·2% organic selenide, 0·1% DBPC, 0·05% quinizarin. V. B.

332. Influence on the oil dielectric strength of the gas pressure in equilibrium with the oil. P. G. Priaroggia and G. Palandri. *J. Electrochem. Soc.*, 1960, **107**, 884–6.—Tests on oil ("NJ2," 25 cS/20° C) for oil-filled cables, 50 cycles, 18°–25° C, 6×10^{-6} to *ca* 10^2 mm Hg, voltage application from 10 kV, at 10 kV/min. Test cell (illustr) glass container (55 ml oil) with 0·5 mm Pt sphere gap. Results show independence of elect strength (*ca* 400 kV/cm) with gas pressure, provided perfect equilibrium obtained between dissolved gas and free gas above oil surface; increase of saturation pressure above free gas pressure lowers elect strength. V. B.

333. White mineral oil in the baking industry. R. T. Bohn. *Cereal Science Today*, 1960, **5**, 234–8.—White oil is used as lubricant for dough dividers, in pan lubricants, and in trough grease, hence small quantities migrate into finished products. Permissible quantity and quality of such mineral oil food component is discussed. U.S.A. allows (temporary) 1500 ppm, U.K. 2000, Canada 3000. Method for determining mineral oil in bread is given. Oil quality should conform to USP/NF requirements and also to uv spectra criteria (*cf* Abs **1707**, 1960). Tests on numerous bread samples showed 117–3360 ppm, mean 904, from dough divider oil; quantities from pan oil and trough grease approx 500 and 250 ppm respectively. V. B.

DERIVED CHEMICAL PRODUCTS

334. Industrial chemicals based on ethylene and propylene. A. F. Millidge. *J. Inst. Petrol.*, 1960, **46**, 353–66.—Ethylene and propylene, which are manufactured today on an enormous scale, are the basic building blocks for a large proportion of the aliphatic organic chemical production. This paper briefly surveys the wide field of chemicals stemming industrially from these two olefins.

New reactions and processes of technical importance starting with these olefins are being continually developed. The oxidn of *iso*propanol to acetone and hydrogen peroxide, the oxidn of ethylene to acetaldehyde, and the reaction of propylene with ammonia and air to give acrylonitrile are recent examples. A. D. S.

335. Recent developments in polyolefins. C. E. H. Bawn. *J. Inst. Petrol.*, 1960, **46**, 374–87.—Since the recent discoveries by Ziegler and Natta of new polymerization cat for olefins such as propylene and butene-1, etc., the whole scope of the polyolefin field has changed. These cat provide the means of stereo-regulation of the side chains, thus enabling polymers to be synthesized in highly crystalline forms.

Several facets of this subject are considered, including the

stereochemistry of the propagation reaction, the mol structure and properties of these polymers, the mol configuration of stereospecific polymers, and the relationship between stereochemical structure and polymer properties. The scope of Ziegler cat systems, the nature of the cat, and the mechanism of polymerization are discussed, and brief mention is made of developments with metal and metal oxide cat.

Whilst the Ziegler type cat have been of major interest, the field of study of new cat, such as lithium alkyls, is rapidly extending. Linear syndioactive polymethyl methacrylate, polyvinyl chloride, and other vinyl monomers have now been made by direct free synthesis from the monomer, and equally important discoveries have been made in the field of olefin oxide polymerization. A. D. S.

336. Acetaldehyde as raw material for acrylonitrile. The Knapsack process for acrylonitrile manufacture from acetaldehyde and hydrocyanic acid. (In German.) K. Sennewald. *Erdöl u. Kohle*, 1959, **12**, 364–8.—Methods for acrylonitrile production from C_2H_4, and C_2H_2 are discussed, with reasons for the hitherto dominating position of C_2H_2. Use of cheap acetaldehyde—made possible by the new Knapsack process—may be of decisive importance for the future raw material situation. The C_2H_2/HCN and the Knapsack acetaldehyde HCN processes are described and compared from the economic viewpoint. Investment and manufacturing costs are the same for both processes. However, the new process gives 10–15% higher yield, and raw material costs are 5–10% lower by using cheap C_2H_4. Transportation is independent of plant location. Seven refs. R. T.

337. Olefins from natural and synthetic sources. E. G. Curphey. *Industr. Chem.*, 1960, **36**, 549–52.—Review of methods for preparation of olefins, including C_2H_4, C_4H_6, and chem syntheses of higher mono- and di-olefins. Nine refs. W. A. M.

COAL, SHALE, AND PEAT

338. Polycyclic hydrocarbons in crude peat wax. M. R. Gilliland, A. J. Howard, and D. Hamer. *Chem. & Ind.*, 1960, 1357–8.—Crude peat wax, extracted from peat with org solvents, was chromatographed into nine major fractions on Al_2O_3. Fraction 2 was separated by solvent extraction and further subdivided by solvent extraction and percolation (twice) through Al_2O_3. Some of the final fractions deposited yellow crystals, which were identified by uv spectrum as perylene. It is believed that other polycyclic hydrocarbons are present in the crude peat wax. Their identification may throw light on the origin of peat. W. A. M.

CORROSION

339. How to fight pretreater corrosion. K. Brooks. *Oil Gas J.*, 17.10.60, **58** (42), 127–8.—The chief causes of corrosion and fouling in the exchanger train following a reformer pretreater are ammonium chloride and iron sulphide deposits and chloride corrosion. An effective solution is to remove ammonium chloride and minimize iron sulphide by intermittent water washing and to control chloride corrosion by injecting ammonia and a filming amine inhibitor. Inhibitor concn is maintained at 20 ppm. and when added was shown to reduce the corrosion rate of carbon steel 0·011 inch pa and 18–8 stainless steels by 0·0014 inch pa. A. D. S.

340. An aspect of the corrosion of mild steel by combustion gases. T. K. Ross, A. J. Macnab, and B. E. Leyland. *J. Inst. Fuel*, 1960, **33**, 540–2.—The effect of reducing constituents on the action of sulphurous combustion gases upon mild steel is studied by flowing various gases over 5 cm × 1 cm × 0·1 cm mild steel specimens contained in an electrically-heated furnace. Scaling-time curves are presented for N_2/SO_2 alone and in admixture with H_2 and O_2. 10% vol H_2 produced a notable acceleration of the attack at all concn of SO_2, whilst 5% vol O_2 served to reduce the corrosion effect of SO_2. A simultaneous addition of 10% vol H_2 and 5% vol O_2 gave approx the same corrosion rate as N_2/SO_2 alone. The scaling rate can be expressed mathematically as:

$$\frac{dw}{d\theta} A = K \left(\frac{T}{100}\right)^{\alpha} (C)^{0.5} \text{ mg/dm}^2\text{h}$$

where $\frac{dw}{d\theta}$ is the weight gain in mg/hr, A the area exposed in dm^2, T the exposure temp in ° C, and C the vol percentage of SO_2 in the gas. For SO_2/N_2 mixtures, $K = 0{\cdot}345$ and $\alpha = 3{\cdot}35$ and for SO_2/N_2 containing 10% of H_2, $K = 0{\cdot}025$ and $\alpha = 5{\cdot}50$. A. D. S.

341. Metals for sea water service. F. W. Pink. *Industr. Engng Chem.*, 1960, **52** (9), 56A.—This short, descriptive paper describes the various factors in sea water corrosion, *i.e.* differential-aeration corrosion cells, cavitation, marine fouling, galvanic corrosion, etc., and then discusses the suitability of steel, cast iron, wrought iron, copper-base alloys, cupronickels, and titanium for sea water use. M. F. M.

SAFETY PRECAUTIONS

342. Some dermatological hazards of today. F. R. Bettley. *Brit. med. J.*, 1960, **ii**, 1467–73.—Survey includes discussion of barrier creams; evidence as to their efficacy is inconclusive; protection against kerosine appears not to be given. V. B.

343. How Shell cut pollution in Rhineland. Anon. *Oil Gas J.*, 31.10.60, **58** (44), 93–5.—Capacity of the Shell Godorf refinery, which is located on the Rhine, between Bonn and Cologne, is 4 million tons pa. All efforts were made to cut water pollution and included use and discharge of as little water as possible, segregation of fuel and contaminated water, discharge of all effluent water in the purest possible form, *i.e.* <10 ppm oil, and prevention of oil seeping into the ground and contaminating ground water. Air pollution was also controlled by reducing evaporation of volatiles in storage, by producing a fuel gas free from sulphur, by bringing the power supply from outside sources, and by building stacks to a height of 325 ft. A. D. S.

344. Detonation—old processes are not immune. O. A. Pipkin. *Proc. Amer. Petrol. Inst.*, 1959, **39** (3), 21–33.—The explosion that rocked the Ponca City refinery of Cities Service Oil Co on the morning of 22 Jan 1959 wrote another costly chapter in the book of experience on detonation as a refinery hazard. Standard Oil Co's violent hydroformer explosion in Aug 1955 emphatically revealed the potential hazard of modern cat regenerative processes, but few of us would look for the same potential hazard in a coking process which had been in operation for over 30 years. From this latest report of a major explosion caused by detonation, the industry will

glean the following: (1) detonation can occur in any process where air is present, through faulty purge procedure or any other cause, assuming the existence of other contributory conditions; (2) start-ups continue to be the most vulnerable period of any unit operation; (3) start-up procedures of old units should be reviewed with reflection on latest technology: each addition or deletion to a start-up procedure should be studied thoroughly, for even the remotest combination of circumstances which might result in hazardous conditions; (4) the problems of human error, even with the most experienced operator, still exist: this offers a challenge for better training techniques; (5) side-by-side operating units are undesirable; (6) grating for platforms probably makes less destructive missiles than floor plate. (Author's abstract.)

ECONOMICS AND MARKETING

345. World oil demand should double by 1975. H. S. Gibson. *Oil Gas J.*, 31.10.60, **58** (44), 103–4.—There is little doubt that the present excess crude availability will disappear within three to four years if the world's rate of increase of consumption continues as it has done since the end of the war. Several independent estimates of future consumption indicate that by 1975 40 million bd crude will be required, which is double the present figure. After 1980, it is suggested that consumption will depend on the rate of discovery, ability to build facilities for handling oil, and the availability of other forms of energy. A. D. S.

346. European petrochemical output rises nearly 500% in 1953–59 period. W. P. Gee, H. A. Kirsch, and C. M. W. Orpen. *Oil Gas J.*, 31.10.60, **58** (44), 96–8.—In terms of carbon content, European petrochemical production has grown from 208,000 metric tons in 1953 to an estimated 1,225,000 metric tons in 1959—an increase of 489%. Growth rate in petrochemicals has greatly exceeded that of total chemicals and total industrials. Comparison with the U.S.A. shows that the European petrochemical industry has now reached the 1947–48 level of this industry in the U.S.A. By 1961 estimated European production should reach the 1953 U.S. level, so that there is considerable further opportunity for growth. Much of the future expansion will occur in chemical areas which have very large *per capita* consumption possibilities, such as synthetic fibres and rubber, plastics, and carbon black. Some of the future expansion will also result from substitution of petroleum for coal as a source of aromatics. A. D. S.

347. Hydrocarbons in the gas industry. Anon. *Petrol. Times*, 21.10.60, **64**, 725.—In the eleventh annual report of the Gas Council for the year ending 31.3.60, the Chairman stated that for the second and successive year since vesting date the industry has shown a deficit, with the prospect of another deficit this year. Several projects are discussed—March 1960 saw the successful completion of the experiment to import liquefied natural gas into Britain, seven voyages with the *Methane Pioneer* having been undertaken. Studies are still being made of the economic aspects of large-scale importation.

Since the capital cost of plant for the hydrogenation of oil, and later of coal, now substantially exceeds earlier expectations, the Council has suspended ordering of plant not yet already under construction.

No new deposits of natural gas in useful quantities have been proved, and the only source which is being exploited is that at Cousland. Exploratory drilling is being undertaken in Kent and Hampshire to examine possible underground storage facilities, and preliminary evidence is encouraging.

A pilot-plant of 200,000 cu ft/day capacity for producing gas suitable for peak-load purposes by cat pressure gasification of light dist should be completed during the financial year 1960–61.

Statistics are presented for gas supplies, including those from oil gasification plants. Use of LPG has continued as a convenient method for producing peak-load gas, but owing to the mild weather last winter total production was only 17·2 million therms. A. D. S.

348. Comparison of performance and octane number requirements of American and European cars. (In German.) G. B. Cipollina *et al.* *Erdöl u. Kohle*, 1959, **12**, 386–92.—Wide variations exist between cars produced by American and European automotive industries, due to different economic and social conditions prevailing in the various countries. In this paper major differences are compared regarding characteristics, performance, and fuel requirements between cars produced in the U.S.A., the U.K., France, Italy, and Germany. Comparison includes a survey on the major characteristics of the respective vehicle populations and an analysis of operating conditions. Effects of car populations and operating conditions are analysed in regard to aspects of fuel and lubricant quality requirements on fuel utilization. The extent to which product quality follows vehicle requirements or is influenced by other considerations is surveyed. R. T.

MISCELLANEOUS

349. U.K. oil industry. V. S. Swaminathan. *Engineer, Lond.*, 1960, **210**, 866–70.—In 1956 oil supplied 13·7% of energy, 1965 estd 22%. Exploratory and production drilling outlined, details of the 11 producing fields tabulated. Survey of refining; main features of recent developments in the larger refineries described. At end of 1957 U.S.A. companies had assets worth *ca* $\$4 \times 10^8$ in U.K. refining. Petrochemicals discussed, at end 1960 15 plants, capital investment £141 $\times$ 10^6, feedstocks (tons) liq $1{\cdot}3 \times 10^6$, gas (1958) 206,000. V. B.

350. Viewpoints for judging the suitability of stone for road building. (In German.) Anon. *Bitumen, Teere, Asphalt, Peche*, 1959, **10**, 182–5.—General viewpoints for judging the suitability of stone for road building are discussed. Relevant methods for determining sp properties are mentioned. Mineralogical composition and granulation are important. Chem analysis gives quant relation of individual constituents. Bulk density is a ref pt for porosity, closely related to water absorption. Frost-resistance is related to porosity and temp changes. Strength tests include resistance to pressure, bending, tension, and abrasion. Grain-binding intensity influences weather-resistance. Softening capacity in water and effects of frost are discussed. Relationships between different strength resistances can be tested variously. Hardness and wear are technically important for determining applicability of stone in road building. R. T.

351. Photosensitized oxidation of propane with X-rays. W. H. Clingman, Jr. *Industr. Engng Chem.*, 1960, **25**, 915.—The photosensitized oxidn of propane with high energy radiation has been investigated as a selective process for pro-

ducing propyl alcohols and acetone. The reaction takes place at room temp over zinc oxide under the influence of γ radiation. Acetone, ethyl alcohol, *n*-propanol, and 2-propanol are the initial products formed, while aldehydes and acids are absent. These initial products react further as irradiation continues.

Propane conversion is a linear function of the radiation dose after an initial line-out period. With one form of zinc oxide, pressure and temp have little effect on conversion. Evidence is presented in the paper that the rate-determining step is the conversion of chemisorbed oxygen to the active oxidizing agent during radiation-induced desorption of oxygen from zinc oxide. Electrical measurements were used to investigate this radiation-induced desorption. M. F. M.

352. Shell at Carrington. Anon. *Chem. & Ind.*, 1960, 1362–5. —Description of petrochemicals installation at Carrington. Production is *ca* 140,000 tons pa. Main products are C_3H_4 and C_3H_6 derivatives and aromatics, including polystyrene. Future production will include polyethylene (high- and low-density), polypropylene, and synthetic rubber. W. A. M.

353. Applied hydrocarbon thermodynamics. Pt 17. W. C. Edmister. *Petrol. Refin.*, May 1960, **39** (5), 207–12.—Nomographs are given for the relative volatilities of hypothetical components, having normal boiling points from 0° to 100° C as a function of temp and bp. A detailed description is included for determining K values from the observed TBP curves of the equilibrium vapour and liq from experimental flash vaporization of a petroleum fraction. The author recommends stills of the Othmer type for determining equilibrium data.

M. J. M.

BOOK REVIEWS

Oil Pioneer. A. Beeby-Thompson. London: Sidgwick and Jackson, 1961. Pp. 544. £2 2*s*.

Although in his foreword to this book Herbert Hoover writes, "This is the life story of an eminent British engineer," it is in fact much more than that. It is a veritable history of the petroleum industry of the world, written by one who has had more than sixty years in the industry, and who has been closely associated with many of the important events in it. Thus the book bears the stamp of authority in relation particularly to the early technical and international developments which have brought the oil industry to its present state of high efficiency.

When the author first visited the oilfields at Baku, Russia, in 1898, drilling speeds were of the order of 7 ft a day and wells took many months to complete to average depths of 1,000 ft. At that time little real engineering practice had been applied to well drilling and oil production, and the author was himself instrumental in introducing practices which led to greatly increased efficiency and output. It is mentioned that in 1900 an area of 4 square miles in the Apsheron Peninsula produced from 1700 wells rather more than half the world's total crude oil output for that year.

Describing his entry in 1904 into the business of consulting petroleum engineer, then almost a closed shop, with Campbell M. Hunter as his partner, the author records how in those days the petroleum expert was expected to, and did, undertake an amazing variety of tasks. Those tasks were accepted without demur. Not the least of the difficulties encountered was the problem of collecting fees, particularly when the report submitted was not encouraging.

In the course of the work of the firm, Mr Beeby-Thompson and his colleagues visited practically every country in the world. Consequently, the range of the book is world-wide in relation to the search for petroleum. The most interesting countries, such as Russia, Trinidad, Roumania, and so on, each have a chapter devoted to them.

Thus in one chapter the author describes various visits to Trinidad from 1906 onwards and gives some interesting accounts of his explorations and adventures. For some years after the first world war the firm maintained an office in Port of Spain.

Countries of the Near and Middle East are extensively commented upon in several chapters. All are well worthy of reading and re-reading, and particularly so the one on Mesopotamia. The account of events in that area from the author's first visit to Mosul in 1925 until comparatively recent times is an excellent study of the country and of events therein in relation to the petroleum industry.

This book is the personal story of a pioneer who has seen an industry develop until it has reached great eminence in the industrial world. It contains the names of many who played important but sometimes unrecognized roles in that development. To those who know something of the industry in the early part of the period, those names will recall many memories. To others, the book will be an inspiration. Intermingled with accounts of technical investigations are many stories of personal adventures which illustrate the hardships and the surprises encountered in the search for oil.

It is fortunate that Mr Beeby-Thompson kept detailed diaries of his daily occupations and that he has been prevailed upon to extract from them the material for this autobiography.

G. S.

Le Pétrole. J. Flandrin and J. Chapelle. Paris: Editions Technip, 1961. Pp. 372. NF 39.

Whilst France has long been an important petroleum refining centre, now, with its capacity of approximately 40 million tons per year, ranking about sixth among countries having a petroleum processing industry, it is only recently that production of petroleum within the French Union has attained an appreciable figure. In 1960, with an estimated output in the region of 12 million tons, it has just about come within the first dozen producing countries.

These circumstances, and especially the discovery of significant petroleum deposits within Metropolitan France itself, including the Paris region, have led to increasing public awareness in that country of the petroleum industry. Books such as this are intended to meet the demand from the educated layman, as well as the student and scientist for whom petroleum technology is not the main discipline, for a general survey of the subject. The volume under review is in fact sufficiently detailed on many aspects of petroleum to act also as a sound introduction for entrants into the oil industry.

After a very brief consideration of the chemistry and physics of petroleum hydrocarbons (doubt may be expressed about the statement that the principal factor governing the viscosity of crude oil is its gas content) the first part of the book (158 pp.) deals with geology, prospecting, drilling, and exploitation of oilfields.

The second part (114 pp.), concerned with the geographical distribution of petroleum, consists of two main sections, one dealing with the principal oil-producing areas responsible for about 90 per cent of world output (U.S.A., Middle East, Venezuela, U.S.S.R., Canada) and the other devoted to the French search for oil, both in the mother

country and in its overseas territories (Gabon, Congo, Algeria, Sahara). Each of the areas covered is discussed geologically, with, naturally, rather greater detail for those under French control. A bibliography (96 references) is appended to cover Parts I and II of the book.

The third part (89 pp.) is entitled "World Petroleum Industry." The first portion of this gives statistics both of reserves and production, the second, whilst headed "storage and transportation," in fact only deals to any extent with the latter (storage being covered in a few paragraphs), mainly in respect of pipelines and sea-going tankers.

Refining and petrochemistry, the subject of the next section of the third part, are only cursorily considered, the whole of "refining operations" occupying less than seven pages. The unqualified statement that crude oil contains olefins, diolefins, and acetylenic hydrocarbons is out of place in a book of this type; whilst the possible occurrence of minute quantities of these in certain crudes is of academic interest, in connexion with the genesis and migration of petroleum, it is of no practical significance and, in the context, to draw attention thereto is misleading.

A chapter is devoted to natural gas and one to the main petroleum companies (five U.S.A., B.P., Royal Dutch/Shell, CFP); the final chapter deals with the French petroleum industry. Here again the lack of balance as between the production and refining sides, seen elsewhere in the book, is evident. The 14 French refineries are listed, with their capacities, but with no indication of the types of plant they possess or the processes carried out. Somewhat unexpectedly, in this chapter most of the statistics relate to 1958, whereas in the rest of the book 1959 figures are mainly given. As for Parts I and II, Part III also has a bibliography attached.

In view of the comment in the introduction drawing attention to the scarcity of general works on petroleum in French, it is a surprising oversight that the bibliography makes no mention of "Pétroles Naturels et Artificiels," by J. J. Chartrou (Armand Colin), which is an excellent little book which would, by its greater emphasis on the refining side, usefully supplement the work under review.

The book is well produced, has several sketch maps and, on the inside front cover, a colour map of France showing location of oil and gas fields, refineries, and pipelines; there are adequate diagrams for the geology and production sections but not one in the refining section.

Considering that the "new" franc had, by 1961, become well established, the footnote to the preface that all prices given are in "old" francs seems, to a non-French reader at least, rather puzzling.

Unlike many French books, this is bound in boards; there is no index, but the contents list is well sub-divided.

V. B.

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OILFIELD EXPLORATION AND EXPLOITATION

GEOLOGY

354. New X-ray computer "fingerprints" rock samples. F. J. Gardner. *Oil Gas J.*, 19.12.60, **58** (51), 133.—A new X-ray and computer procedure has been developed which operates automatically for determining the mineral composition of rock fragments. The equipment consists of an X-ray machine designed to memorize the characteristics of 35 commonly found minerals. Data are derived from standard samples of minerals, and samples of rocks are ground to powder and fed as a paste on a slide into the machine. As the X-ray beam bombards the samples, the X-ray data are punched into cards. Identification is then done by the computer. It is claimed that 150 samples can be processed per day. C. A. F.

355. Hydraulic fracturing in the light of geological conditions. E. T. Heck. *Prod. Mon.*, Nov 1960, **24** (11), 12–19.—Consideration of geological stresses and evidence from photographs and log data indicate that the mechanism of hydraulic fracturing is that of opening rock joints, resulting usually in vertical fractures, rather than a lifting of the overburden. G. B.

356. Deep Wilcox, Frio, and Edwards spur upper Gulf Coast activity. Anon. *World Oil*, Nov 1960, **151** (6), 119.—Several significant deep finds have been reported from the upper Gulf Coast area during the past year. Pays range from Lower Cretaceous Edwards limestone up through Oligocene Vicksburg and Lower Frio. The main search is for gas. Important recent discoveries are described for the

Edwards limestone trend, the Wilcox, Newton–Jasper Wilcox, Yegua, Vicksburg, and Frio. C. A. F.

357. How Lower Frio changes in depth. A. H. Wadsworth. *World Oil*, Nov 1960, **151** (6), 123.—The Gulf Coast has been interpreted as a quiet sedimentary basin in which marine beds were deposited in alternation with non-marine. Tectonic activity was thought to be slight except around the many salt intrusions, but new data from deep wells along the Frio trend suggest that the complexities in these deep rocks cannot be explained by quiescent conditions. Lower Frio deposition was affected by diastrophic forces comparable with those of mountain building intensity; these created spectacular structural and stratigraphic conditions. The "typical" structure with anticlinal closure on the downthrown side of a fault is not so typical in the Lower Frio, and it is hazardous to map a shallow marker and to project this to deep levels. Much of the Lower Frio trend is made up of arcuate fault blocks which are tilted to the N and have steep S faces. Structural relief may be over 1000 ft. These blocks are buried below middle and upper Frio sediments, and dip closure can be found at the S end of a block where beds drop over or become down-faulted. Structure shifts with depth and a S dip is crucial for deep production. The discovery of these deep closures needs flexible geological and geophysical interpretation. C. A. F.

358. The Deep Edwards trend. Pt 2. G. R. Pinkley. *Oil Gas J.*, 28.11.60, **58** (48), 112.—22 fields have so far been discovered along the Deep Edwards trend in SW Texas. 18 of these are gas fields, three oil, and one produces oil and gas. Several wildcats are being drilled, and future prospects of the trend are thought to be good. The play extends some 200 miles, and new fields are being continuously discovered. Details of individual fields are given. C. A. F.

359. Better double check the Cimarron. C. A. Shaw. *Oil Gas J.*, 12.12.60, **58** (50), 164.—There are some 17 pays in E Cimarron County, Oklahoma, and there are prospects of additional producing zones in the Tubb–Red Cave which may lead to the area becoming a very important producing region. The geology of the Cimarron arch area is outlined; it is a broad N–S uplift which was being developed as early as the Mississippian with later movements through Pennsylvanian, Permian, and possibly Mesozoic. There are locally steep dips associated with faulting. Main pays are Pennsylvanian Morrow sands, including the Keyes sandstone; these are reviewed and the geology of the Keyes and Griggs fields outlined. Exploration is carried out by study of aerial photographs, facies changes, and subsurface structural interpretations. C. A. F.

360. Tule Creek play moves west, after failure to east. F. J. Gardner. *Oil Gas J.*, 12.12.60, **58** (50), 161.—The most significant well in the Williston Basin in 1960 was at Tule Creek in Roosevelt County, Montana. The discovery, Murphy Corpn 1 Sletvold, found oil in Devonian Nisku at 476 bd of 42° oil from *ca* 7700 ft. Later wells were dry because of tight pay, but there are now indications that the area may prove to be of commercial significance. The first well in the area was drilled in 1957, and the recent discovery was drilled following a seismic survey. C. A. F.

361. Eubank may be next Kansas oil and gas producing giant. F. O. Bennett. *Oil Gas J.*, 19.12.60, **58** (51), 134.—The discovery and development of the Eubank field are described. It is located within the Hugoton gas field, *ca* 7 miles S of the Pleasant Prairie field. Most of the production in the area is shallow gas from Permian Chase dolomitic limestones at 2300–2750 ft. Although the first gas well was completed in 1922, no attempt was made until the 1950's to evaluate the deeper Pennsylvanian and Mississippian formations in the interior Hugoton. Following the discovery of the Mississippian Pleasant Prairie field in 1954, intensive exploration was carried out and 1 Eubank was completed in 1958 for 506 bd from the Chester sand. Several further discoveries were later drilled in the same area, and it is expected that these will prove a continuous pool within a structure approx 5 miles wide by 5–10 miles long. It is a multi-pay field, and details of the reservoir rocks are given. C. A. F.

362. Gas reserves of Western Canada. J. G. Stabback. *Canad. Min. metall. Bull.*, 1960, **53**, 470–6.—The geology of the W Canada sedimentary basin is briefly discussed and the history of oil and gas development outlined. The total established reserves are 29·5 trillion cu ft. Ultimate reserves are estimated as between 260 and 300 trillion cu ft. Predictions are made concerning future production and economics. G. B.

363. Jordan needs more wildcats. Anon. *Oil Gas J.*, 12.12.60, **58** (50), 168.—In spite of recent exploration no oil or gas fields have yet been found in Jordan, and this country and Lebanon are now the only two states in the Middle East which do not have proven fields. Several dry holes have recently been drilled, the latest being in the El Lisan peninsula near the S end of the Dead Sea. This was carried to below 14,000 ft. Structural core drilling and geological surveys have been carried out, together with gravity surveys. There are many oil and gas seeps in the El Lisan area.

Jordan forms part of the Middle East foreland, which contains three distinct provinces: (1) the Massif zone of deformed pre-Cambrian rocks; (2) the Arabian shelf; and (3) the orogenic–geosynclinal zone. Oldest producing rocks are Palaeozoic Nubian sandstones in the small Suez fields, and there are important pays in Jurassic, Cretaceous, and Tertiary rocks elsewhere in the region. In spite of recent search in Jordan, the country had not been explored yet in detail, and much work remains to be done. C. A. F.

364. Oil exploration in the Sahara. A. Perrodon and C. Tempere. *Petroleum, Lond.*, 1960, **23**, 419.—The geography and geology of the vast Sahara desert region are given in a general way, with a geological map and cross-section of much of the area. The three basins at present producing gas or oil are dealt with in more detail: the Ahnet–MacMahon Province has large gas reserves (*ca* 50 billion cu m), but isolation prevents exploitation; the Fort Polignac Province includes the producing fields of Edjele and Zarzaitine; the NE Province includes the fields at Hassi-Messaoud and Hassi R'Mel. Finally, there is a short section considering future policies of exploitation and exploration. G. D. F.

365. Distribution and description of Siluro–Devonian Chitinozoa from some CREPS, CFPA, and SN Repal wells in the Sahara. P. Taugourdeau and B. de Jekhowsky. *Rev. Inst. franç. Pétrole*, Sept 1960, **15** (9), 1199–260.—Chitinozoa are known from Cambrian to Carboniferous, and recorded from various parts of the world, seemingly being the most frequent and widespread microfossils. The size is 50–1500 μ. Because of deep weathering the Saharan rocks rarely yield organic microfossils from outcrops. Samples were therefore obtained from wells at Ghardaia–Timimoun, In Salah and Edjele.

200–500 g was washed, dried, crushed, and the 1–3-mm fraction collected. This was treated for 3 hr with 30% nitric acid, followed by cold 55% hydrofluoric acid, boiling with HCl, and treatment with alcohol, with intervening washings on 63 μ screens to give a few centigrammes of residue. This treatment is being modified.

The mounts are examined at 100 and 400 magnifications by top and bottom light.

The approx ages of the sections were known, and some Ordovician was included, the whole being divided into ten

zones for the studies. Diagrams show the range of certain forms in terms of these zones. Only *ca* 20% of the samples had more than two individuals per g of rock, and the finer-grained types gave greater yields. The Chitinozoa were rare in the base of the Ordovician, passed through a max in the Gothlandian, and then decreased. Some forms were most abundant in rocks showing certain types of microfossils, and there was association of forms. The results of other statistical studies are also given.

Species of Chitinozoa are described, and over 160 forms are illustrated. A third of the forms occurred over areas over 500 km in dia; half the forms did not extend beyond two of the time zones. *Cyathochitina*, *Conochitina*, and *Lagenochitina* as genera occurred throughout the sequence, but were especially abundant in species and numbers in the Ordovician. *Ancyrochitina* and *Desmochitina* were important in the Gothlandian and early Devonian. *Sphaerochitina* and *Angochitina* were especially abundant in Upper Gothlandian and Lower Devonian. G. D. H.

366. Strike in Cambay area promises big field. Anon. *Oil Gas J.*, 21.11.60, **58** (47), 157.—Wildcat Ankleshwar-1, *ca* 100 miles S of Cambay in Giyarat state in W India, will produce *ca* 2100 bd on commercial production from *ca* 3870 ft. The crude is less waxy than that from Cambay, and the field may prove to the largest in India. J. C. M. T.

367. Red China claims large oil resources are being developed. R. Westgate. *World Oil*, Nov 1960, **151** (6), 138.—Oil development in Communist China is discussed. In ten years production has risen from *ca* 2000 to *ca* 60,000 bd and in the last two years production is reported to have increased by approx 50%. There has been very intensive and successful exploration in recent years, and many oil-bearing structures have been found. A map shows sedimentary basins and established fields in China. Four major fields are known: Karamai, Yuman, Central Szechwan, and Tsaidam. There are also very large coal deposits, and shale oil has been obtained for many years. The geology of the main oilfields is outlined and prospects of the country reviewed. C. A. F.

368. Netherlands confirms large gas reserves. Anon. *Oil Gas J.*, 28.11.60, **58** (48), 58.—Two finds of natural gas have been made in N Netherlands, one at Delfzjil and one at Slochteren, the former in a Carboniferous reservoir. Reserves are estimated at 2 trillion cu ft or more. J. C. M. T.

369. Vienna Basin as a petroleum province. (In German.) H. Wieseneder. *Erdöl u. Kohle*, 1959, **12**, 533–7.—Vienna Basin is illustrated and defined as the inner Alpine sedimentary space, also the E Austrian molass zone. In regional petroleum geology a series of fields belonging to one geological unit has proved exceptionally fruitful, yielding 99% of Austrian crude oil production. On an Alpine rock basis is built a sedimentary series of 800 m Helvetian, 1500 m Tortonian, 1200 m Sarmatian, 1000 m Pannonian, 80 m Lower Pliocene, and 200 m Pleistocene. The basin filling of 11,390 km³ sedimentary materials consists of *ca* 30% sand and sandstone, *ca* 60% Pelite, the remainder conglomerates, breccia, and organogene limes. The main ingredient of all the clastic sediments of the Vienna Basin is quartz, also recognized in the granular fractions <0·002 mm. Complex sedimentation and tectonics lead to many petroleum occurrences in the Vienna Basin. Stratigraphy of the Matzen field, which yields 82% of Austrian crude oil, is discussed. A second group of fields, Zisterdorf oil region, consists of closed anticlines, semi-domes, or semi-anticlines; the geology is discussed. Further oilfields occur in the Vienna Basin in the Lower Tortonian, also Zwersdorf gas field. Sands and sandstones are the chief reservoir rocks in the Vienna Basin. 20 refs. R. T.

370. Microstratigraphy and biofacies of the Carpathian flysch of Southern Moravia (Czechoslovakia). V. Pokorny. *Rev. Inst. franç. Pétrole*, Aug 1960, **15** (7–8), 1099–1141.—The external or flysch Carpathians developed structurally during the Tertiary, the last major thrusting movements being in the Tortonian. In Moravia the internal zone is the Magura nappe, and the external zone is comprised of the Silesic nappes of E Moravia and the sub-Silesic nappe. The Magura flysch has two facies; Solan beds, mainly sandstone or conglomerates, with some clays and passing into greywackes; multiple thin alternations of sandstones and clays. Microfossils show the age to range from Upper Senonian to Middle Eocene. The non-carbonate assemblages are considered to point to marine conditions. The conditions did not favour deposition of $CaCO_3$.

For the external flysch uninterrupted sedimentation from Cretaceous to Tertiary is supposed from analogy with rocks farther E, but it has not been possible to demonstrate this in the region examined at Zdanice. Campanian and Paleocene have been indicated by fossils, as well as Lutetian. The Pouzdrany marls are Upper Oligocene.

Various microfossils are illustrated, and the distribution of some forms is given. A simplified geological map is appended. G. D. H.

371. Soviets claim huge reserves in desert area. Anon. *Oil Gas J.*, 31.10.60, **58** (44), 71–2.—Soviet geologists believe that the desert region E of the Caspian has reserves equal to those of Baku on the W shore and the so-called "second Baku" between the Volga and the Urals. New oil and gas discoveries have recently been made in Turkmenia (at present producing 32,000 bd), and a new gas field at Gazli is believed to be the largest in the U.S.S.R., if not the world. The new province is bounded by two established areas of modest oil production—Cheleken on the W and the Ferghana Valley on the E. Oil-bearing horizons cover a wide stratigraphic range, and 15–20 producing horizons are commonly encountered in a given well. J. C. M. T.

DRILLING

372. A guide to job-rating a well for minimum rig horse power in jet bit drilling. J. W. Peret and J. E. Kastrop. *Petrol. Engr*, Oct 1960, **32** (11), B19.—By making certain clearly stated assumptions, values of the minimum hp for the hydraulic and hoisting systems for jet bit drilling operations can be calculated. Sample calculations are given. Finally, results of such calculations are tabulated for hole sizes from $6\frac{3}{4}$ to $12\frac{1}{4}$ inches and depths from 5000 to 10,000 ft. G. D. F.

373. Design and operation of jet-bit programmes for maximum hydraulic horse power, impact force, or jet velocity. H. A. Kendall and W. C. Goins. *J. Petrol. Tech.*, Oct 1960, **12** (10), AIMME Tech. Paper No. 8129, 238–50.—Several investigations have shown drilling rates to increase significantly with increase in hydraulic hp. Some claim that there is the max effect on drilling rate when bit hydraulic hp is a max, others that the jet impact force is most important, or that max jet velocity is needed. The problem has been studied in terms of given pumps and other equipment, leading to developing ranges of operation, surface and bit pressures, and flow rates to give a max of any of the desired effects. Proper selection of nozzle sizes and the application of rules developed will allow the max obtainable quantities to be effectively used at all depths. A simple graphical method of choosing nozzle sizes and flow rates is given. There is a decided advantage in compounding pumps for max bit hydraulic effects. High-

pressure operation is important for max bit hydraulic effects, and there is need for pumps which will provide this without undue maintenance problems. G. D. H.

374. How to increase bit weight for less cost. J. M. Kellner and A. P. Roberts. *World Oil*, Nov 1960, **151** (6), 131.—There is a trend towards higher bit weights with the use of longer and larger dia drill collar strings to give added weight. This leads to longer trip time and higher hoisting power demands, and in order to obtain high weight near surface a new high output force applicator was developed, known as the hydraulic wall-anchored drill collar. This provides bit loading without using dead weight, and in shallow holes it is possible to eliminate the need for long drill collar strings. The tool is described in detail; it has two main parts, a push-down section, and an anchor section with a retaining latch. Photographs show the tool. Results of shallow tests are briefly described. C. A. F.

375. Air motor drill promises drilling improvements. H. J. Magner. *Petrol. Engr*, Oct 1960, **32** (11), B46.—The air motor drill consists of two vane-type motors driving a common shaft at *ca* 4000 rev/min. A reduction gear is used to drive the drill at 400 rev/min. The tool is fixed at the bottom of the string, and the compressed air is fed down the drill pipe. Experimental field tests are reported. These show that drilling rate is increased considerably, and it is possible to drill straighter holes in steeply dipping formation than with conventional methods. Costs are considered briefly. G. D. F.

376. Measurement of dynamic characteristics of perforating shaped charges by the use of ultra high-speed photographic techniques. D. E. Brink, T. C. Poulter, and B. M. Caldwell. *J. Petrol. Tech.*, Oct 1960, **12** (10), AIMME Tech. Paper No. 8131, 78 (summary).—The performance of jet perforators depends complexly on *ca* a dozen variables, and performance data are no simple guide to the influence of different parameters. Detonation to complete penetration takes *ca* 100 microsec, and the tip velocity may exceed 30,000 ft/sec. Flash X-ray, rotating streak camera, and the rotating-mirror framing camera have provided information on the action of shaped charges, but are incapable of giving data on the liner collapse phase of jet formation. To overcome this a stereoscopic technique using the framing camera has been developed. Analysis of the stereoscopic photographs has permitted the determination of liner collapse profiles. G. D. H.

377. How to calculate bit weight and rotary speed for lowest cost drilling. I. E. M. Galle and H. B. Woods. *Oil Gas J.*, 14.11.60, **58** (46), 167.—With a carefully selected type of bit, drilling fluid, and hydraulic programme, bit wt should be increased as bit dulls. With tungsten carbide bits, wt and speed should remain constant. The proper variation of wt and speed depends in both instances on drilling fluid, trip time, rig cost/hr, and bit cost; with other than carbide bits, on the abrasiveness of the formation also. The basic formula employed is that drilling rate $= C_f(W^k r/a^p)$, where C_f = formation drillability parameter, W = bit wt, r is essentially rotary speed to a fractional power, a is a function of the square of the bit dullness, $k = 1{\cdot}0$ for hard to $0{\cdot}6$ for soft formations, and $p = 1{\cdot}0$ for flat-crested to $0{\cdot}5$ for self-sharpening bit tooth wear. The derivation of the formula is discussed. J. C. M. T.

378. New 8-inch air hammers cut drilling costs in big holes. J. E. Eckel *et al.* *Oil Gas J.*, 7.11.60, **58** (45), 125–8.—A new 8-inch hammer drill extends air or gas percussive drilling to a hole size of 13¾ inches. Design is similar to an earlier 6¾-inch tool, but the energy output is *ca* 22% higher, and field tests in Central Arkansas show it to be superior in performance. Penetration rate was 1⅝ to 2½ times higher than with conventional rotary air drilling. A simple rubber non-return valve was found to prevent cuttings from entering the body of the tool when drilling through wet formations. J. C. M. T.

379. New formation-interval tester. Anon. *Oil Gas J.*, 21.11.60, **58** (47), 168.—A new self-contained wire line device can perforate and test suspected zones in cased wells down to 5½ inches and open holes down to 6 inches dia. A γ-ray detector and pressure gauge are incorporated. Two heavy-duty shaped charges 8½ inches apart are used, and these are surrounded by seals which are pressed into contact with the formation by a spring-loaded shoe on the opposite side of the tool, isolating the formation from the mud in the hole. J. C. M. T.

380. Acoustic log measurements in Germany. (In German.) G. Tuchel. *Erdöl u. Kohle*, 1959, **12**, 537–41.—An instrument is illustrated and discussed for supersonic measurements in deep drillings. The object is registration of the velocity of rock strata to the abs minimum thickness. Thereby correlation possibilities are expected from drilling to drilling and information on porosity, also gas or oil cont of traversed strata. In the log diagram measurements of horizons obtained by seismic reflection methods are inserted. The effects of changes through mud circulation, drilling operations, water absorption, and swelling of clayey strata are discussed. Porosity, not possible to estimate, requires parallel elec or γ-ray investigations. Based on drilling core investigations, the acoustic log is a measure for max possible porosity. It is advisable to adjust any small errors to the true velocities obtained by geophone measurements. Accurate sunken geophone measurements are almost impossible near salt plugs. Supersonic measurements give true val. Seven refs. R. T.

381. Flying rig in Bolivia. Anon. *World Petrol.*, Aug 1960, **31** (9), 54.—A new rig has been developed for airborne exploratory drilling to be carried out in Central Bolivia. Much of the area is difficult of access, necessitating airborne transport. All the equipment can be disassembled for helicopter transport into groups not exceeding 4000 lb weight and not exceeding 8 ft by 8 ft by 28 ft in size. The rig is designed to drill a 6¼-inch hole down to 15,000 ft with a tapered string of 4-inch and 3½-inch light-weight drill pipe. Details of the equipment are given. C. A. F.

382. The microlog as a porosity datum for the neutron log in the Swan Hill field, Alberta. M. M. Holgate. *Canad. Min. metall. Bull.*, 1960, **53**, 502–6.—Procedures are described for deriving porosity neutron deflection scales by cumulative correlation and for transforming microlog readings by means of a porosity–permeability function obtained from core analysis to serve as a datum for the neutron log. The relations derived are valid only for a particular field. G. B.

383. New organic fluid-loss-control additive for oil well cements. C. M. Stout and W. W. Wahl. *J. Petrol. Tech.*, Sept 1960, **12** (9), 20–4.—The fluid-loss-control additive should not adversely affect desirable cement properties, should act in a predictable manner for various cement densities, and not be costly in relation to the benefits. D-23, a high mol wt synthetic polymer, which is water soluble and stable up to 300° C, appears suitable. It had little or no effect on thickening times of API Class A Portland cements, and retarded thickening in Class D and E cements, except when much bentonite is present. The compressive strength of set cements was not affected. There are no mixing problems, but visc problems exist if its concn is over 2%. Low fluid loss is an important factor in squeeze cementing. D-23 markedly reduced fluid loss, and in conjunction with bentonite has made it easier to cement casing in high-permeability zones. Success has been achieved in squeeze cementing, especially with the

low-pressure hesitation technique. 50 wells have been squeeze cemented, with perforations over 2–230 ft, at depths of 1500–14,500 ft, and temp of 80°–310° F. G. D. H.

384. Modern well-completion series. Pt 8B. Formation testing fundamentals. C. R. Richardson. *Petrol. Engr*, Sept 1960, **32** (10), B64.—The tests carried out and the information obtainable in open and cased holes are dealt with. Many of the pieces of equipment used are sketched, and there is a short section dealing with recently developed techniques. G. D. F.

385. Engineering practices manual. Pt 2. Care and maintenance of tool joints. S. G. Marshall and C. R. Frederick. *World Oil*, Nov 1960, **151** (6), 81.—Costs of drill string can be minimized by proper care and handling of tool joints and drill pipe in the field. Equipment requirements and rules for the care of tool joints are discussed. For equipment the drill string should be planned to permit good operating practices, mechanical equipment should be in top working condition, and a good torque gauge should be available for checking catheads. Only a good grade thread lubricant should be used together with thread protectors. Eight rules for the breaking-in period are listed, and the importance of the initial make-up is emphasized. In general practice, serious trouble usually gives early warning, *e.g.* connexions difficult to break. Ten rules of care are given, and it is emphasized that if warning signs of failure are ignored a series of expensive fishing jobs can result. Care must be taken in transport and storage and protection given against corrosion. Corrosion is mainly caused by: (1) presence of salt in fluids; (2) bacterial action; (3) presence of air and/or CO_2 and H_2S in drilling fluids. Control measures are listed, including the internal coating or peening of the drill string. C. A. F.

386. Russia speeds electric drill development and testing. Anon. *World Petrol.*, Aug 1960, **31** (9), 44.—Slim hole electric drilling at bottom hole is being extensively tested in the U.S.S.R., and this type of bottom drill will probably supersede the turbo-drill, which requires a relatively large dia for satisfactory operation. The electric drill was first developed in 1952, and it is reported that 100 rigs in Russia are now fitted with this type of drilling tool. It has several advantages including: (1) control of weight and torque, and speed of bit; (2) continuous recording of deviation; (3) control of hp. It is uncertain whether the drill would withstand the much higher hydraulic hp and pressure drop used in the W, due to extensive use of jet tricone bits. Other features of Russian rigs include automatic break-out tongs, automatic pipe racking, and the provision of two rotary tables so that no pipe is stacked. In recent years *ca* 80% of all wells drilled in Russia have used the turbo-drill. Formation pressures are relatively low, and high hydraulic hp and pumps are not required. C. A. F.

387. Offshore drilling in Iran. J. D. Wells. *World Petrol.*, Aug 1960, **31** (9), 40.—Offshore drilling operations by Pan American in the Persian Gulf are described. Exploration wells are being drilled offshore from Persia using a De Long 144 self-elevating mobile platform 200 ft long, 104 ft wide, and 15 ft deep. It has eight steel legs, which on location can be jacked down through the water to the Gulf bottom. Full details of the platform are given with photographs. It is fitted with all modern equipment and conveniences. There is a 15-ft hull giving facilities for storage of 310 tons of cement and mud, 290 tons of drilling water, 100 tons of salt water, 100 tons of potable water, and 200 tons of fuel oil. C. A. F.

388. Rotary drilling in low pressure loss formations. 3. Sealing operations and special methods for reducing loss. K. Hartland. *Petroleum, Lond.*, 1960, **23**, 424.—This part first considers the use of various cements and sand oil plugs for sealing in order to overcome mud loss in low pressure formations. Pressure surges are shown to be important factors in choosing correct drilling programmes. Finally, several special methods are mentioned, together with their advantages and disadvantages, including blind drilling, frothed "muds," and hydraulic methods. G. D. F.

389. A practical look at slim-hole drilling. B. A. Aggers. *Petrol. Engr*, Nov 1960, **32** (12), B34.—"Slim" holes are here defined as those designed to take casing strings of less than $5\frac{1}{2}$ inches od. The reasons (mainly economic) for using slim-hole methods are outlined, and the design of equipment for slim-hole drilling is described. The costs of conventional and slim-hole wells are compared by means of tables. It is shown that penetration rates, bit life, etc., are very similar in the two cases. Some of the disadvantages of slim holes are outlined. G. D. F.

390. Basic guides for the selection of economic hole size for slim-hole drilling. W. W. Moore. *Petrol. Engr*, Oct 1960, **32** (11), B60.—It is shown that in all except shallow wells, very slim holes are not feasible because of the decrease in ruggedness of rock bits as the size is reduced. Other problems arising from the drill collar, mud pumps, drill pipes, etc., are mentioned. A "slenderness ratio" K is introduced, defined as well depth/unit cross-sectional area of the hole. The value of K depends on the qualities of the formation being drilled. The optimum hole size is therefore $d = \sqrt{L/K}$, L being the depth. This relationship is plotted as a large chart giving d as a function of L for various values of K. G. D. F.

391. Effect of drilling mud treating agent on the membrane potential. L. B. Lipson and H. L. Overton. *J. Petrol. Tech.*, Aug 1960, **12** (8), AIMME Tech. Paper No. 2065 (summary), 80.—The sodium single ion equivalent activity concept when used to determine the filtrate resistivity–activity relationship for 150 lab and 49 field drilling muds gave results within 20% of that for pure NaCl sol, except for phosphate high-resistivity muds and calcium-treated muds. G. D. H.

392. New mud organic. R. A. Jung. *Oil Gas J.*, 24.10.60, **58** (43), 129.—Principal troublesome contaminant of drilling mud in the Gulf Coast region, U.S.A. is formation clay. Control of swelling in these clays can be achieved by adding electrolytes, but a number of factors have to be held within close limits by further additives. This control is difficult to achieve in practice, while high temp have an adverse affect on such complicated muds. The addition of a new heavy-metal lignosulphonate complex is an alternative method of control claimed to be insensitive to salt contamination and to high temp. Compared with a gypsum dispersed mud, large savings in weighting material, bits, and rig time have been shown in use in Louisiana. J. C. M. T.

393. Mud mixing idea saves $20,000 per rig. J. E. Kastrop. *Petrol. Engr*, Sept 1960, **32** (10), B28.—The use of centrifugal pumps instead of reciprocating pumps for mixing mud is shown to lead to large savings. The modifications necessary in the piping, etc., when the new pumps are used are listed, with numerous diagrams. G. D. F.

PRODUCTION

394. Effect of completion fluids on well productivity in permafrost, Umiat field, Alaska. G. L. Gates and W. H. Caraway. *J. Petrol. Tech.*, Oct 1960, **12** (10), 33–40.—In the Umiat area permafrost extends to depths of *ca* 1000 ft. 11 wells were drilled and all had evidences of oil. Several types of drilling mud were used. The productive Cretaceous Grandstand formation is in the zone of permafrost. Cores showed

the presence of clays with intermediate swelling properties. Four wells were drilled with cable tools and brine to minimize the seemingly harmful effects of the muds in the first three holes drilled by rotary. The cable-tool wells averaged 70 bd of oil, although one gave under 1 bd. No. 5 was first drilled with cable tools and brine, then reamed with rotary and oil to stimulate output; it had a potential of *ca* 400 bd. No. 2, only 200 ft away, was dry, having been drilled with water-base mud. In No. 9 no oil was obtained in a series of 4-hr packer tests over a succession of intervals during drilling, but oil entered the hole when the oil-base mud was swabbed from the well. A cement plug was drilled out with brine and the casing was perforated, but no production was obtained. Water from the cement might have frozen in the pores, or swelled the clays. Seemingly, oil-base mud gave the best wells, followed by brine, with fresh water muds giving no production. Some failures may, however, have been due to poor permeability. G. D. H.

395. Miscible displacement-flow behaviour and phase relationships for a partially depleted reservoir. J. F. Wilson. *J. Petrol. Tech.*, Oct 1960, **12** (10), AIMME Tech. Paper No. 8127, 223–8.—The tests were made on 26–27-ft long sandstone cores *ca* 2 inch dia, 22% porosity, 45–49 mD N_2 permeability, and 19 mD brine permeability. The cores were initially saturated with brine, then charged with separator oil, followed by reservoir fluid at 260° F and 4815 psia. The cores were depleted to 2015 psia, giving *ca* 20% gas saturation, slugs introduced, followed by driving gas at 2050 psia. Phase equilibrium studies were made in a variable-vol cell at 260° and 2015 psia.

Miscible displacement will be applied to partially depleted reservoirs, and the initial flow of the injected material will be mainly in the gas channels, causing swelling of surrounding oil, and ultimately piston-like displacement will develop. The process will cause a rapidly declining GOR first, then a nearly constant GOR until breakthrough of the injected fluid.

Small amounts of asphaltic matter were precipitated during the displacement, but seemed to have no adverse effects on the operation. The slug composition required for 100% oil recovery was found to agree with that found from the equilibrium phase studies. G. D. H.

396. Miscible fluid displacement–prediction of miscibility. A. L. Benham, W. E. Dowden, and W. J. Kunzman. *J. Petrol Tech.*, Oct 1960, **12** (10), AIMME Tech. Paper No. 8128, 229–37.—Miscible displacement of typical reservoir fluids by hydrocarbon mixtures usually involves a number of mixing and separation stages. Pseudo-ternary representation of the methane–intermediates–heavy components system is rigorous if the pseudo-components are completely characterized in one phase. Because the character of the pseudo-components changes during the displacement, a large number of constant pressure and temperature ternary diagrams are needed for rigorous illustration of the complete process. The limiting conditions for miscibility depend largely on conditions near the critical point, and near-exact representation is possible by using an intermediate fraction like that in the injection mixture and a heavy-fraction like that of the reservoir fluid. The limiting tie line is tangent to the phase envelope at the critical point on the ternary composition diagrams. The position has been approximated by a vertical line. Miscibility between injection and reservoir fluids is indicated for points on the intermediate components side of this line.

Conditions for miscible displacement of five typical reservoir fluids by various light hydrocarbon mixtures have been calculated for temperatures of 70°–260° F and pressures of 1000–3000 psia. Correlations have been developed and applied with good success to published data on displacement studies. A partial check of the correlation was made by step-wise tests in a windowed PVT cell. G. D. H.

397. Gas and oil segregation in oilfield reservoirs. H. Gilmour. *J. Inst. Petrol.*, 1960, **46**, 383–90.—In the exploitation of crude petroleum reservoirs, the segregation of gas and oil may have pronounced effects upon primary recovery, particularly in the types of reservoirs in which gas initially in solution in the reservoir liquids provides the dominant expulsion mechanism by gas liberation and expansion. Prerequisites to effective conservation of energy arising from segregation are the geometric structure, which requires to provide a sufficiently large transition zone area, appreciable closure and dip of structure to minimize direct gas production from the gas-segregated zone, isotropic rock texture, so that vertical permeabilities are of the order of magnitude of that along the bedding planes, and the exercise of reservoir development and control, particularly with regard to selection of well locations in the structure and limitation of component pressure gradients in funicular gas and oil phases in the vicinity of the transition zones. This development and control involves general limitation of production rates from reservoirs and wells throughout periods, within which segregation is a significantly effective component mechanism, and particular limitation of production (or cessation) from wells whose zones of influence are suspected of encroaching on the segregation zones as development proceeds. Gross analytical description of the history of expanding gas caps has been attempted in the literature, as a consequence of cumulative recovery by frontal advance, but analytical evaluation of cumulative gas migration from the oil zone to gas cap is avoided and the migration considered as a fraction of produced gas. Elsewhere in the literature differential forms of the volumetric balance are modified to include a component of expansion of migrated gas. Migration being a component mechanism, rate of migration is related to the free-fall rate of flow along the bedding plane, employing the lesser of the phase mobilities. The former of these approaches to description of production histories involving segregation drive cannot be accepted as satisfactory, and the latter requires the inclusion of an analytical description of segregation rate and expansion of segregated gas. The purpose of the paper is to offer analytical expressions for instantaneous rate of segregation, for the criteria for its occurrence, and for consequent modification of the differential form of volumetric balance.

(Author's abstract.)

398. How to minimize production costs. L. C. Uren. *World Petrol.*, Aug 1960, **31** (9), 45.—In order to compete effectively with the free world market, the oil and gas industry in the U.S.A. is faced with an urgent need to reduce production costs, and engineering studies have shown many ways of doing this. Unit production costs can be reduced by maintaining production at higher rates to avoid artificial lifting; this may be done by such means as gravel packing the well, acid treatment for limestones, or by hydraulic fracturing. Wider spacing can be used, the discounted present value of future production being increased by closer spacing. Automation can permit field operations to be continued with less labour. Labour is usually the main cost item in production, and its more efficient use can have material savings. Economies in headquarters organization may be possible.

Economic advantages of slim-hole drilling and permanent completions are outlined, and the use of air or gas instead of mud is shown to be effective in reducing costs in certain cases.

C. A. F.

399. Automatic lease systems. W. J. Rapson. *World Petrol.*, Aug 1960, **31** (9), 48.—Lease automation techniques have been adopted in increasing numbers in recent years in the oil and gas industry. By assessing these techniques into functional groups it is possible to make practical analyses to determine optimum automation methods. Six phases are discussed: (1) well control; (2) manifold control; (3) test

metering; (4) automatic programming; (5) data recording; and (6) custody transfer. These are shown in schematic diagrams. Economic considerations include manpower reduction, transport savings, reduction in facilities costs, safety, and improved information. Each phase of an automated system should be economically evaluated; some phases may offer considerable savings, but others may be expensive and indicate only small returns. Other savings may be provided by processing well test records using automatic record processing equipment. C. A. F.

400. An evaluation of a satellite system in the Pembina field. H. L. Brusset and C. A. Y. Shephard. *Canad. Min. metall. Bull.*, 1960, **53**, 583–6.—The system described consists of a central treating installation and four automatic well testers to which the 40 wells are connected in groups. At each testing station, called a "satellite," the wells are connected in sequence by an automatic programmer to the test equipment, the remainder being connected directly to the treating plant. Oil, water, and gas from the well under test are separated and metered. The items of equipment at the satellites and central plant are described. The entire system has operated satisfactorily without attention at the satellites for long periods. It is necessary to ensure that the pressure drop is low and constant. G. B.

401. Unique wireline workover converts dual to triple well. G. S. Rohe and W. L. Porter. *World Oil*, Nov 1960, **151** (6), 115.—A two-string dual completion has been successfully converted to a triple completion. The well is in Brazoria County, Texas, and wire-line tools were used for the conversion involving a new pressure actuated jet perforator which remains in the hole after firing. Diagrams show completions before and after the conversion. The problem was complicated by an abnormally high bhp in the lower sand of the dual, and it was found necessary to carry out all the wireline work before perforating. A 10-ft jet perforator was developed, and this was fitted with a hydrostatic firing device. No shooting line was required for detonation. Details of completion procedures are given. C. A. F.

402. How Conoco makes non-commercial field pay off. R. Casey and J. C. Shepler. *World Oil*, Nov 1960, **151** (6), 109.—Large vol fracture treatments have been used to convert the Sacatosa field in SW Texas into a commercial venture. A unique automation system is also to be installed, permitting field data to be transmitted automatically to a data processing centre. The field was found in 1955 following an aerial photo survey which showed a fault along the central part of the Chittim arch. Production comes from the San Miguel sand (Upper Cretaceous), and the reservoir is a stratigraphic trap due to sand pinch-out across the arch. Max gross sand is 80 ft above oil–water level. Wells showed marginal production, and commercial production was obtained only after fracture treatment. Standard drilling and completion practice is now followed. Tubing is run before fracturing so that the well can be produced immediately after the treatment. The latter consists of fracturing down the casing–tubing annulus using 30 brl blanket lease crude treated with 0·10 ppg fluid loss additive. 131,500 lb of 20–40 mesh sand are then pumped down using lease crude treated with fluid loss additive. Initial load oil production after fracturing is usually 100–200 bd. The automation system is outlined. C. A. F.

403. Gas–oil ratio response of water floods in which injection equals withdrawals. G. H. Agnew. *Canad. Min. metall. Bull.*, 1960, **53**, 598–606.—A method is presented of calculating the change of gas–oil ratio with time when water is injected at just sufficient rate to maintain the reservoir pressure constant and the pressure has fallen below the bubble point before flooding is commenced. The procedure is illustrated for two actual cases. The calc and actual performance were in good agreement. G. B.

404. Case history of a gravity drainage type reservoir. R. E. Martin. *Canad. Min. metall. Bull.*, 1960, **53**, 607–13.—The Westerose Leduc (D-3) pool, which is a Devonian reef reservoir in Central Alberta, is described. The nature of the formation is conducive to the separation of the oil, water, and gas by gravity. Gas liberated by reduction of reservoir pressure collects in the gas cap. From a consideration of past performance it is concluded that gravity segregation is operative even at high production rates and that primary recovery will be high even without pressure maintenance. G. B.

405. Determination of bottom hole pressure in a flowing gas well. S. S. Dhillonn and F. W. Cole. *Canad. Min. metall. Bull.*, 1960, **53**, 607–13.—A method of calculation is presented which is quicker than, and as accurate as, other known methods. It is based on repeated calculation of the slope of the pressure *v.* depth curve for different depths. One or two calculations generally suffice. For great accuracy a programme, which can be obtained from the authors, has been prepared for the IBM 650 digital computer. G. B.

406. The handling of sour well fluids in the Pincher Creek field. W. J. McGuire *et al.* *Canad. Min. metall. Bull.*, 1960, **53**, 633–42.—The corrosive agent considered is H_2S, which causes stress cracking. On the basis of lab tests and field experience low carbon steel is recommended where high strength is not required and K-monel or C–Mn–Mo and AISI 4140 steels where high tensile strength and hardness are needed. Welded joints are especially vulnerable. If corrosion is discovered by inspection of components or test coupons the rate of damage can be reduced by corrosion inhibitors. G. B.

407. What about gas lifting tubingless completions? P. J. Thrash. *Petrol. Engr*, Sept 1960, **32** (10), B33.—The possibility of gas lifting in slim tubingless completions is considered. It is shown that quite large vol of fluid can be gas lifted in such slim completions. The effects of gas tubing size, valves, injection depth, etc., are considered. The gas lifting of dual completions is dealt with also. G. D. F.

408. New method predicts polished rod input power requirements. J. R. Norton. *Petrol. Engr*, Sept 1960, **32** (10), B56.—A method of calculating the input power requirements to the polished rod string in pumping wells is given. Loads and velocity are assumed to vary in a sinusoidal manner. A sample calculation is given. Calculated and measured hp agree closely. G. D. F.

409. De Moss flood handles early water breakthrough problem. E. A. Riley and B. G. Williams. *J. Petrol. Tech*, Oct 1960, **12** (10), 11–14.—The De Moss field of Archer County, Texas, was found in 1941 and had 27 producers on ten-acre spacing by June 1950. Production was solution gas drive from the Strawn (Basal) sand at *ca* 3600 ft, in a stratigraphic trap. The upper of two sand bodies is the main producing horizon. The oil visc is 2·1 cP and the connate water saturation 32%. Production decline began in Nov 1950, and small hydraulic fracture treatments were applied to most wells in Jan 1951. Peak production of 35,674 brl occurred in April 1951; output was 3150 brl in Jan 1957 for a total recovery of 1,101,039 brl. Some water encroachment had occurred in the SE. Eight water injection wells were used in a pilot flood, water being obtained from the Thomas sand at 1000 ft. Produced water is recycled, being compatible with the supply well water in a closed system. Flooding began in July 1957, and all adjacent wells responded by Feb 1958, two wells having breakthrough in March. A full scheme was in operation a few months later, with peak oil output of 36,276 brl in Aug, water injection being 122,563 brl. All wells averaged 18,000 brl of oil at initial

breakthrough. Selective plugging failed to cure troubles arising from ½ ft of sand taking 32% of the water, and high injection rates were undertaken, with increase in fluid output rates. A total shut-down for a short period led to a marked drop in oil rate (1100–1200 bd to 850–950 bd on resuming operations). G. D. H.

410. Effect of vertical fractures on well productivity. W. J. McGuire and V. J. Sikora. *J. Petrol. Tech.*, Oct 1960, **12** (10), 72–4.—The model studies assumed a square drainage area with fractures extending towards the nearest neighbours. If all wells are similarly fractured the individual drainage areas are unaltered by the fractures. An electric analyser was used, a well drainage area having 576 elements of equal vol and resistance. Shunts of various lengths and resistances simulated vertical fractures. A 6-inch well with 40 acres drainage was studied. Vertical fractures make the flow pattern intermediate between radial and linear, causing pressure variations from point to point of the external boundary during flow. A generalized productivity index was used to evaluate the results of fractures, the drawdown being the average pressure within the drainage area minus the bottom-hole flowing pressure. The results are given as plots of relative productivity index *v.* relative fracture conductivity for different values of the ratio fracture length/drainage radius. It is evident that there is little to be gained by increasing the conductivity of short fractures. For fractures with relative conductivities between 10^3 and 10^4 a two- to six-fold rise in productivity occurs, and the benefits are largely independent of fracture length. G. D. H.

411. Study of gas-cap water injection in a peripheral water flood. J. D. Griffith *et al.* *J. Petrol. Tech.*, Sept 1960, **12** (9), AIMME Tech. Paper No. 8126, 216–22.—The Sholem Alechem field of Stephens County, Oklahoma, is a faulted anticline with dips of 400–1000 ft/mile. Fault Block A had major sealing faults on the E and W and a pinch-out to the S. The water-flooded Sims sand averages 100 ft thick, with porosity of 19%, permeability averaging 160 mD, and 23% interstitial water. The three zones are produced together in most wells, and the upper two have gas caps. Peripheral water injection began in 1955, and in 1956 gas injection into the gas cap began to prevent oil being lost by entering the cap. After six months there was evidence of gas leakage from the cap; later there was an indication of other undesirable features, while the needs of the larger E gas caps would have required the purchase of gas.

Scale model studies were made on the feasibility of forming a water barrier to prevent oil entering the gas caps. The models were of shaped plexiglass containing glass beads which gave a permeability of 4·7 D. The wells had 270-mesh screen, and simulated 20-acre spacing (the field had ten-acre spacing). The studies suggested that the injected water would form a continuous barrier, and would advance uniformly down-dip without gravity segregation, provided that a minimum water injection rate was maintained. Water injection at the edge of the gas cap began in 1958, and on first breakthrough at a down-dip well after a year the vol injected corresponded with the prediction. Without this injection it appeared that 27×10^6 brl of oil would be lost to the gas caps. G. D. H.

412. Water flood performance in a stratified, five-spot reservoir—a scaled model study. D. H. Gaucher and D. C. Undley. *J. Petrol. Tech.*, Sept 1960, **12** (9) AIMME Tech. Paper No. 8125, 208–15.—The model was one-eighth of a five-spot with the hypotenuse 4 ft long and the wells at the acute angles. The sand was 1·4 inches thick, representing 20 ft for 20-acre spacing. Refined mineral oils and $ZnCl_2$ soln were the fluids. Six models included uniform sand, high-permeability top layer, and high-permeability bottom layer, the layers being 0·7 inch thick. The water injection rates differed in different experiments. Transparent walls allowed observation of flood behaviour.

The vol of oil recovered by injecting a given vol of water increased slightly as the rate of water injection decreased for reservoirs with 0·5 or 2·17 cP oil. The highest recoveries were obtained when the upper sand was *ca* twice as permeable as the lower sand. Gravity segregation was observed in homogeneous sand, and the oil recovery at a given vol of water injection was essentially independent of rate. Recovery efficiency was greater for low than for high visc oils. G. D. H.

413. PVT behaviour of methane in the gaseous and liquid states. D. E. Matschke and G. Thodos. *J. Petrol. Tech.*, Oct 1960, **12** (10), 67–71.—Compilations of experimental data for methane have been made in the form of reduced density *v.* reduced temp for various values of reduced pressure on a log–log basis and on rectilinear co-ordinates. The saturation-vapour locus was extended to lower reduced temp via the saturated vapour densities of N_2, O_2, and CO, on the basis of the principle of corresponding states for materials having similar critical compressibility factors. Extension of the isobars to the saturated vapour line in the low-pressure region was achieved by means of similar information on the density of argon in this region. In the compressed liq region, for which no methane data are available, a suitable relationship was used to allow the employment of data for nitrogen.

The reliability of the plots was tested by comparisons with experimental data. Reduced density values are also presented in tabular form. G. D. H.

414. Automatic custody-transfer system at Lake Pelto, Louisiana. J. T. Tansil and L. M. Moor. *J. Petrol. Tech.*, Oct 1960, **12** (10), 15–19.—Estimates showed that automatic custody transfer could reduce oil storage requirements by 60–70% as compared with a conventional system, and the additional cost was *ca* that of 1000 brl of storage at the water location. The installation began operation in Nov 1957 with three wells and has been expanded and refined. A large platform has the production control manifold, separator, and four 1000-brl tanks; a small platform carries oil-treating facilities, pipeline station, and custody transfer equipment. The well-head controls are purely safety devices. Rotary-type choke bodies permit changing production rates without shutting in. Two motor valves on each well manifold allow opening, closing, or testing to be done. A BS & W monitor allows diversion of production through treating facilities when needed. High level controls in tanks and pressure vessels close in wells to prevent loss of oil or damage to production equipment. A well-test programmer causes the wells to be tested in sequence. Dump-type meters are used for liq measurement. The custody-transfer unit measures and continuously regulates the vol of oil leaving the property. Positive displacement meters with automatic temp compensators, visible registers, and ticket printers are used with a meter prover and sampler. The monthly transfer controller has a "set-stop" counter. The pumps are controlled by the amount of fluid in the delivery tank.

Over 1×10^6 brl has been metered and transferred. A gauging check of 12,425·22 brl showed a metered vol excess of 0·0139%. The pipeline station had some operating difficulties. G. D. H.

415. Calculation of crude oil recoveries by steam injection. B. L. Landrum, J. E. Smith, and P. B. Crawford. *J. Petrol. Tech.*, Oct 1960, **12** (10), AIMME Tech. Paper No. 8130, 237A (summary).—In a linear uniform flow system the position of the steam front at a given time, and application of the Buckley–Leverett theory to the hot and cold regions have been used to obtain the displacement efficiency of a steam in-

jection process. A bank of water condensed from steam together with connate water develops. There is no appreciable region of hot water or hot oil.

Calculations show for a ten-acre linearly flooded reservoir with oil *ca* 35 times as viscous as steam, the recoveries with steam were 20% more than for water flood; for oil of 500 cP, steam gave three to four times as much oil as conventional water flood. G. D. H.

416. How to analyse your gas lift wells. K. E. Brown and C. Canalizo. *Oil Gas J.*, 28.11.60, **58** (48), 72–9.—Analysis of charts recording simultaneously tubing and casing pressures in gas lift wells enables many forms of trouble to be detected early. Other methods of checking performance from the surface include regular measurements of production and of gas injection vol. The best means of determining the working condition of a gas lift installation is by a down-hole flowing pressure survey, and this should be done while a well is performing satisfactorily, when it may disclose that improvements may be made to valve spacing. Tubing leaks will also be located. The lubricator and master valve should be installed the day before the test, to allow flow conditions to return to normal. Tubing leaks can also be found by means of a flowing temp survey, though the method is less valuable than a pressure survey. Acoustic methods of determining fluid level in the annulus are suitable for installations without a packer. J. C. M. T.

417. New stimulator keeps wells producing. C. J. Lawrence. *Oil Gas J.*, 7.11.60, **58** (45), 151–2.—A new well stimulator acts by providing a mild back-flush to prevent perforations from plugging. The method is intended mainly for shallow wells with unconsolidated sands, and has been found satisfactory in five out of six wells in a field in the Los Angeles Basin. The tubing is raised and lowered 8 ft by means of hydraulic rams, and swab cups attached to the tubing string above the perforations force well fluid from the annulus into the formation. The number of cycles varies from one/day to several/hr, and is controlled automatically. J. C. M. T.

418. Design of sucker-rod strings. J. Zaba. *Oil Gas J.*, **58** (43), 139.—Since the load on a rod string increases progressively up the well, " tapered " rods have come into use in deep wells to save costs and decrease pumping loads. Two or more sizes of rod are used. Sizes are chosen so that either stresses are made equal in the top rods of each section or reach an assigned max in each section. The first method gives lighter and cheaper strings. J. C. M. T.

419. Material balance forecasts with initial production data lacking. W. Rose. *Prod. Mon.*, Nov 1960, **24** (11), 24–9.—It is shown that material balance calculations can be made by known methods of calculation when initial production data are lacking. The limitations of the method are discussed. G. B.

420. A study of chamber lift. T. E. W. Nind. *Canad. Min. metall. Bull.*, 1960, **53**, 488–94.—In the chamber lift technique a chamber fills with oil which is then lifted as a slug of from 1 to 3 brl by gas injection. The gas pressure is not applied to the formation. The cycle is controlled by the automatically timed operation of one valve, other valves being opened and closed at the proper times by differential pressure. The technique is suitable for wells with very low productivity index. The selection of suitable wells, size of equipment, rate of gas injection, and timing of the filling and lifting cycle are considered quantitatively. G. B.

421. The plugging effect of bacteria in sandstone systems. R. T. Hart, T. Fekete, and D. L. Flock. *Canad. Min. metall. Bull.*, 1960, **53**, 495–501.—The plugging effect of bacteria, independently of their metabolic products, was studied by injecting sandstone cores with suspensions of dead *Bacillus subtilis*, which is a rod-like organism of similar size ($4 \times 1\ \mu$) to most of the bacteria found in injection waters. The rate and extent of plugging was dependent on the concn of bacteria and independent of the permeability of the cores used (all of similar structure from the same formation). G. B.

422. Performance of an alternate repressuring and producing project. G. E. Crosby and R. J. Cochran. *J. Petrol. Tech.*, Sept 1960, **12** (9), 39–41.—The Frio D-7 sand lens of the Rincon field of Starr County, Texas, has two wells. The sand occupies 38 acre-ft and is at 3230 ft. The porosity was taken as 23%, and interstitial water 24%. A pressure of 1523 psi was assumed. Primary production was 80,820 brl of oil and 159,872 Mcf of gas, a volumetric estimate of oil in place being 433,905 brl. Water flooding was not thought practicable with only two wells and much of the oil round the down-dip well. Repressuring without production was planned to get oil from outlying and/or low-permeability parts of the reservoir when production was resumed. Since 1956 there have been seven cycles of repressuring and production, the output of the producer being limited to 30 bd to minimize gas breakthrough. Gas injection totals 76,676 Mcf, production being 11,864 brl oil and 71,644 Mcf gas. Operating costs of $12,257 and investment of $5,862 have yielded revenue of $33,219. The pressure has been built up to successively higher values. G. D. H.

423. Tubingless completions: a review of equipment, economies, and techniques. J. F. Muse. *J. Petrol. Tech.*, Sept 1960, **12** (9), 13–19.—Most U.S. work on tubingless completions has been in relatively shallow areas where production can be handled through $2\frac{7}{8}$-inch casing. In addition to saving on tubular goods and well-head fittings, some companies have reduced drilling costs for 3000- to 5000-ft wells by using highly portable three-man truck- or trailer-mounted drilling units. The holes have been $5\frac{1}{8}$- and $6\frac{1}{4}$-inch. This saves on mud and cement also. Development is proceeding on $4\frac{1}{4}$-inch bits. There has also been saving on perforating, sand fracturing, and squeeze cementing.

$2\frac{7}{8}$-inch od, 6·4-lb, J-55 casing has commonly been used, but $3\frac{1}{2}$-inch od, 5·7-lb casing costs less and gives greater clearance for washing over. Multiple strings in $7\frac{7}{8}$- or $8\frac{3}{4}$-inch holes are run either separately, which is cheaper and quicker, or with the strings clamped together. Provision is available for drilling out cement, perforating, acidizing, and artificial lift. A slim-hole pump can lift 113 bd, a hydraulic pump 350 bd; hollow rods and gas lift can give 220 bd and 250 bd, respectively. Greater amounts of production present a problem, and so does severe corrosion. G. D. H.

424. An approach to the evaluation of oil-production capital investment risks. R. S. Wansbrough. *J. Petrol. Tech.*, Sept 1960, **12** (9), 25–30.—The problems involve the comparison of investments having different degrees of risk, and measuring the present value of future income. In the widely advocated discounted-cash-flow rate of return an interest rate is found which gives a discounted value of future earnings equal to the investment amount. This appears to be biased in favour of high initial income projects. There is overstatement of the penalty for deferment of income. A method is therefore proposed to take note equitably of the time value of money, the attractiveness of the investment relative to alternative possible investments, and the relationship between the degree of risk and the minimum acceptable level of profit. A relationship is derived $M = 1/p - S(1 - p)/p$, where M is the minimum return on investment needed to make the present value of income from successes and failures equal to the present value of investment, S is the ratio of present value of money recovered from a failure to the present value of the investment amount, and p is the prob-

ability of getting the predicted results from the project. An example of the use of the method is given. G. D. H.

425. Application of slim-hole completions to secondary recovery. J. Hinckley. *J. Petrol. Tech.*, Sept 1960, **12** (9), 31–4.—In 1942 Stekoll started a flowing-type water flood in the Bolton field, Kansas. Costs of the usual 4½-inch casing completions were compared with 2-inch casing. It was decided that in the 1000-ft injection and producing wells 2-inch casing would be a saving, and the total development costs were reduced by a third. Later in Kansas an attempt was made to pump inside 2-inch casing using a string of 1-inch line pipe as tubing and rods. Over 15 years the operating cost was equivalent to that of conventional wells. In one area comparisons showed recoveries per acre-ft with 2-inch casing to be the same as with 4½-inch casing, while operating costs were less for the slim-hole completions. Since 1950 several hundred wells at Corsicana have been completed slim-hole with no special problems. In 1954 at Panhandle 2⅞-inch tubing was used as casing and 1-inch upset tubing as tubing, with a 20% saving in total well costs at 3000 ft. A slim-hole completion was made at 5000 ft in Cochran County, Texas. Elsewhere flowing production has been obtained at 8700 ft, and 71 bd has been pumped from 6800 ft through 1-inch tubing in 2⅞-inch casing.

A joint of 4½-inch casing is put on the bottom of the narrow casing as combination float and guide shoe. One perforation per foot by jet is common. In fracturing total perforations have been limited to 10 holes/treatment, assuming 12–14 brl/min max injection rate. The 1-inch pumping string is run with a hook-wall pump packer without packer rubbers. Special tools have been developed for use inside narrow casing.

At 3000 ft up to 100 bd of fluid can be handled through 1-inch tubing. New couplings are being developed for greater depths.

The quantities of fluid to be produced or injected must be considered in planning slim-hole completions. Friction losses for injecting 1000 bd at 5000 ft are under 25 psi. Slim-hole completion may save 30% on injection wells. G. D. H.

426. West German petroleum and natural gas exploration in 1958. (In German.) H. Boigk. *Erdöl u. Kohle*, 1959, **12**, 457–64.—Intensified search in known oil-promising areas is shown in the number of drillings and metrage drilled. Investigation of structures and reservoirs of NW German sedimentation regions is in the foreground. Investigation includes parts of the troughs with thicker sediments and the peripheral regions with reduced deposit development. Oil–geological relationships in the region of the Pompeian fault block were explored by individual drillings. The most important result of the report year was detection of an oil-bearing facies dip in the pinching-out Bentheim sandstone E of the Ems. Equally remarkable was discovery of a new discordance deposit on the E edge of the E Holstein Dogger syncline. Zechstein exploration was favourable, resulting in two gas deposit discoveries in the primary dolomite, and two exploration well producers in the Gifhorn syncline. After assuming regular production Diepholz entered the field series. As a result of further drilling activity in the middle and N trough of the upper Rhine valley three new oilfields or discoveries and one new gas field are recorded. The Alpine foreland stood indisputably at the peak of the success, with two oil and five gas deposits. In the report year the portion of drillings for Zechstein investigation was especially high, of these also some Presaline. The total of producing wells at the end of the report year had risen to 85. At the same time 16 gas wells were producing. R. T.

427. Liquid-density correlation of hydrocarbon systems. A. Madrazo. *J. Petrol. Tech.*, Aug 1960, **12** (8), AIMME Tech. Paper No. 2064 (summary), 80–1.—The Standing–Katz correlation for hydrocarbon systems is easy to handle, depends on easily accessible data, and gives adequate accuracy. It has been tested using experimental data for 154 reservoir fluids. The results prove that the correlation is satisfactory, and correction curves have been developed to improve the accuracy. Apparent densities must be used for methane and ethane when saturated in crude oils in employing the correlation. G. D. H.

428. The Pembina miscible displacement pilot and analysis of its performance. J. J. Justen *et al. Canad. Min. metall. Bull.*, 1960, **53**, 507–14.—The Cardium Sand reservoir of the Pembina field is a stratigraphic trap with neither bottom water nor free gas. The primary recovery is estimated at 12·5%. Recovery can be increased 2·5 times by water flooding. A miscible displacement test was conducted with LPG driven by gas. By comparison of the calc with the actual performance, equations were developed for the distribution of the LPG. These showed that permeability stratification was a controlling factor in oil recovery. Stratification was reduced by injecting water into the partially swept reservoir. The results showed that miscible displacement with LPG is suitable for secondary recovery from this reservoir. G. B.

429. Scaling laws for laboratory flow models of oil reservoirs. F. M. Perkins and R. E. Collins. *J. Petrol Tech.*, Aug 1960, **12** (8), 69–71.—It has been stated that the relative permeabilities to water, oil, and gas and the dimensionless capillary pressures must have the same values in model and prototype; the visc ratios must also be the same. However, the more permeable model sands will have connate water and residual oil saturations different from the prototype, and so the scaling requirements on the above aspects are not usually met.

After defining oil and water relative permeabilities with reference to a specific permeability to oil at connate water saturation, and dimensionless water saturation as $(S_w - S_{cw})/(1 - S_{ro} - S_{cw})$ the scaling requirements are: (1) dimensionless initial and boundary conditions similar; (2) the relative permeabilities and dimensionless capillary pressure are the same functions of the dimensionless saturations. These scaling criteria are less restrictive than those previously used. The new definitions ensure agreement of "relative permeability"–"saturation" plots at the terminal values. G. D. H.

430. Applications of nuclear science in petroleum production. M. Williams. *J. Petrol. Tech.*, Aug 1960, **12** (8), 11–13.—Geochronological measurements have been made by the use of natural radioactivity, including the dating of comparatively young sediments by means of carbon isotopes. Radioactive "spikes" have been employed to facilitate the measurements. Radioactivity logging has various forms: measurement of natural γ radiation for correlation; back-scattered γ-rays for density, and indirectly porosity logging; neutron logging capable under some conditions of detecting neutron capture by chlorine with the possibility of distinguishing oil from water; neutron logging effectively detecting hydrogen near the borehole. Methods are under test which may directly detect oil or give data on rock composition.

Radioactive tracers have been used in cementing operations, to detect permeable zones, and for tracing gas and fluid movements in production. Suggestions have been made that nuclear explosions might be used to break up oil shales prior to *in situ* combustion to liberate oil, and that radioactive waste might be injected into reservoirs to cause breakdown of very viscous crudes. G. D. H.

431. Measuring oil flow rates using standard oil–gas separators. H. P. de Wit. *J. Petrol. Tech.*, Aug 1960, **12** (8), 30–4.—Metering of output is essential for optimum control of a field,

but manpower requirements may limit individual well gauging. For some years the automatic recording of the filling of a standard vertical separator has been used. The amount of oil was determined by means of the rise in hydrostatic pressure in filling. Filling is followed by dumping, the cycles being counted. Various forms of separator instrumentation are available; sliding and hinged floats; gap-acting controllers. A filling stage of at least 15 minutes is advised, but fair accuracy has been obtained with 3 minutes. Gauging of live oil by a metering separator which depends on wt seems likely to be more accurate than dipping. The records provide evidence of rate of production; gauge tanks are eliminated from block stations; less oil stock is tied up. However, skilled labour is needed for operation and installation. G. D. H.

432. Correlation of oil formation volume factor and solution gas–oil ratio. C. R. Knopp and C. A. Ramsey. *J. Petrol. Tech.*, Aug 1960, **12** (8), 27–9.—Differential liberation data for 159 saturated E Venezuelan crudes have been used in a plot of temp-reduced formation vol factor against solution gas–oil ratio. The crudes had API gravities of 15°–47·5°, the reservoir temp being 142°–307° F. Gas–oil ratios were 0–3500 cu ft/brl. Comparison of values obtained from the correlation with lab determined formation vol factors gave an average error of 2%. The average error of 104 separator flash tests was 1·97%. With the aid of an aux correlation to correct from 60° F to the reservoir temp for oils of different gravities it is possible to use the gas–oil ratio measured during production to predict the oil formation vol factor for saturated crude with accuracy adequate for making oil-in-place calculations. G. D. H.

433. Field examples of nuclear magnetism logging. P. Hull and J. E. Coolidge. *J. Petrol. Tech.*, Aug 1960, **12** (8), 14–22.—Free precession of protons about the earth's magnetic field lines is used in nuclear magnetism logging. Only hydrogenous fluids contribute to the signals. The amplitude and rate of decay of the signals depend on the type of fluid, its temp and visc, its distribution within the formation, and the magnetic field conditions. In practice, signals are not recorded from bound fluid in clays, fluids over *ca* 600 cP visc, in formations with less than 0·5% porosity, or much magnetite.

The free fluid log is given in terms of the percentage of free fluid in the formation (FFI). Fluid identification is also possible by means of the thermal relaxation characteristic. The rate of thermal relaxation is markedly affected by matrix conditions, and is usually quite high for water in water-wet rock. The free fluid log can be used for correlation.

A number of field examples of nuclear magnetism logging are given and discussed. The FFI can give a measure of permeability and productivity. G. D. H.

434. Performance predictions for low productivity reservoirs. R. D. Carter and G. W. Tracy. *J. Petrol. Tech.*, Aug 1960, **12** (8), AIMME Tech. Paper No. 8123, 195–200.—Some solution-gas drive reservoirs, because of tightness, have high draw-downs at the wells. The wells may give less than their allowables, even initially. Wide spacing is economically necessary, and fracturing may be needed. The pressures and saturations will be far from uniform, vitiating the use of steady-state radial flow and material balance approach to predicting performance. As an alternative the two-phase flow equations have been solved for flow into a single well for various size and capacity horizontal fractures. The results were compared with conventional calculations. Allowance was made for gas/oil ratio penalties, and for the fractured reservoirs the producing rate was controlled by this penalty rule for much of the well's life. There was an early rise in producing gas/oil ratio, followed by levelling off before the normal rise set in.

Fracturing gave greater ultimate recoveries, higher average producing rates, and lower average reservoir pressures at given recoveries. The two-phase calculations showed less optimistic reservoir performance than the conventional calculation. G. D. H.

435. Nuclear magnetism logging. R. J. S. Brown and B. W. Gamson. *J. Petrol. Tech.*, Aug 1960, **12** (8), AIMME Tech. Paper No. 8124, 201–9.—A logging device has been developed based on the measurement of the nuclear magnetism of formation fluid. It can operate in oil or water-base muds and in empty holes, but is not effective in rocks with appreciable amounts of magnetic minerals (a further device is planned to detect these). One measurement gives a continuous formation fluid curve (free fluid log), and seems to give the effective porosity, for there are no readings in shales, although they contain water. The sonde is kept at the side of the hole and the effects of drilling fluid are suppressed by dispersing powdered magnetite in it or by the presence of powdered steel, resulting from drilling operations. This log can be used for correlation.

Preliminary work has been done on a second kind of measurement which requires the tool to be stopped for a short time opposite the zone of interest in order to obtain nuclear magnetic relaxation curves. In some cases these curves allow oil and water saturations to be estimated, or oil and water to be distinguished. G. D. H.

436. Water flood calculations for multiple sets of producing wells. S. A. Hovanessian. *J. Petrol. Tech.*, Aug 1960, **12** (8), 65–8.—The Buckley–Leverett non-linear partial differential equation can be reduced to two first-order, linear differential equations by the method of characteristics. The method can be applied to the water flood recovery problems involving one line of injection wells and multiple lines of producing wells, and the extension requires that the slope of the characteristics be changed whenever a change in production occurs.

A numerical example of the use of this technique is given, and it is concluded that the total oil recovery and water injection were the same for single and multiple sets of producing wells. G. D. H.

OILFIELD DEVELOPMENT

437. The part you play in unitization. Various. *Petrol. Engr*, Sept 1960, **32** (10), B98.—Five papers dealing with unitization (*i.e.* the combination of resources on a given oil pool) are reported. These were presented at an API meeting in Los Angeles in May 1960, and deal respectively with the importance of unitization, the petroleum engineer and unitization, the landsman's role in unitization, the legal aspects of unitization, and the landowner's view of unitization. G. D. F.

438. New fracture-propping process uses aluminium pellets. J. E. Kastrop. *Petrol. Engr*, Nov 1960, **32** (12), B40.—Research on the use of small, malleable aluminium pellets as a fracture-propping agent is described. The concn of pellets in the fracturing fluid, the particle size, carrying fluids, and injection rates have been investigated. Some field tests and practical problems encountered are reported. The use of sand and aluminium pellets together is also mentioned. G. D. F.

439. Texas drillers are beginning to concentrate more on exploring offshore possibilities. J. C. McCaslin. *Oil Gas J.*, 5.12.60, **58** (49), 163.—Exploration offshore from the coast of Texas should increase, and there are four active wildcats at present drilling off Galveston and Jefferson Counties. There are now 11 established offshore Texas fields, extending from Kleberg County at Sprint, NE to the Block 20–5 field off

Sabine Pass. Some fields produce gas and oil, others gas or gas-condensate. There are also four areas which are offshore extensions of onshore fields: Kain (gas), S Sargent (gas), Caplen (oil), and High Island (oil). Off Louisiana there are 130 fields where geological conditions are more favourable than off Texas, a thick Miocene section being developed. It is suggested, however, that there may be a trend offshore from Texas similar to the Balcones fault zone. C. A. F.

440. Radioactive isotopes trace well treatment results. W. E. Johnson. *Petrol. Engr*, Sept 1960, **32** (10), B40.—The determination of vertical extent of hydraulic fracture treatments and acidizing treatments by means of isotopes is dealt with. The equipment and types of tracers used are mentioned. Tracer surveys on a number of wells in the Illinois Basin are reported. G. D. F.

441. Recent developments in Canada's gas and oil industry. V. Taylor. *Internat. Oilman*, 1960, **14**, 220–1.—The oil and gas fields in Canada lie in a belt running parallel to the W Canadian Basin from SW Manitoba and SE Saskatchewan through Central Alberta and NE British Columbia. Production is between 550,000 and 600,000 bd, mainly from Devonian rock, although the max efficient rate is over a million bd. The production is carried by pipeline to Vancouver and Toronto. Refineries at Montreal use cheaper imported oil. The most likely future outlet lies in increased export to the U.S.A. Any fields discovered in the extreme N would be well situated for the N European markets, if the problem of ice can be solved. The known reserves are 6×10^9 brl plus 300×10^9 brl in the Athabasca sands. G. B.

442. French move to meet soaring demand. R. F. Hagemann. *Oil Gas J.*, 31.10.60, **58** (44), 105.—The development of the French oilfields is outlined. Both the Rhine Graben and the Rhone Valley have proved disappointing, and the main exploration effort in Metropolitan France is focused on the Paris and Aquitaine Basins. Production in the Paris Basin comes mainly from the Upper Jurassic Dogger formation, and is controlled partly by structure but more by variations in porosity and permeability. In the Aquitaine Basin, production is from Lower Cretaceous Albian and Aptian formations. In Algeria production is from Cambrian sandstones and also Carboniferous, Devonian, and Ordovician formations. Discovery dates and methods, producing formation age and extent, number of wells, gravity of oil, production, and reserves are listed for all existing fields. J. C. M. T.

TRANSPORT AND STORAGE

443. Microballoons in oil storage. Anon. *Petrol. Times*, 2.12.60, **64**, 824.—Urea–formaldehyde resins in the form of tiny spheres are used to produce a floating seal on the surface of oil stored in cone-roof tanks. These microballoons are made by spray-drying the resin slurry, and besides finding application in preventing evaporation loss, are used as fillers in polyester resins, and in boat and automotive manufacture. In storage tanks the spheres are injected under the crude oil, where they rise to form a layer of ½–1-inch thickness on the surface. Evaporation is reduced by 80–90%, and normally the cost of a microballoon installation can be recovered within a year by the amount of oil saved. A. D. S.

444. Mobile underwater storage unit built. Anon. *Petrol. Engr*, Nov 1960, **32** (12), B84.—A brief article describes a mobile unit designed for service in the Gulf of Mexico for storing up to 20,000 brl of crude under water, to allow for economic transportation. The unit also supports living quarters, etc. G. D. F.

445. LPG underground storage capacity to climb 24%. R. B. Bizal. *Oil Gas J.*, 28.11.60, **58** (48), 85–90.—Capacity to store LPG in underground formations in the U.S.A. will reach 60,785,000 brl when projects now under way or planned are completed—this is nearly 24% higher than that reported in 1959. This increase in capacity goes hand in hand with two important factors—building of new LPG pipelines and the increase in domestic demand for LPG. The new storage space is being created not only in leached-out salt formations but also in mined caverns in areas where salt structures do not exist. A breakdown is given of storage in the U.S.A. and Canada by states, reporting the capacity and type of product involved. A. D. S.

446. Poly-urethane coating solves storage problems. Anon. *Oil Gas J.*, 28.11.60, **58** (48), 92.—In order to solve corrosion problems consequent on the storage of jet fuels in steel tanks, poly-urethane coatings have been tried as internal protectives. The formulation of the coatings is given, and it is stated that a total of 220 gal of material was needed to cover the 6200 sq ft of a tank's inner surface with a 6-mil coat. The coating was applied in seven working days and is expected to last for five years. A. D. S.

447. Liquid methane behind the Iron Curtain. I. C. I. Kelly. *Petrol. Times*, 2.12.60, **64**, 817–21.—In trying to assess when the Russians first began to liquefy natural gas and to store it, a review is given of negotiations for and delivery of plant from the U.S.A. It is known that the Moscow LSR works came into commercial operation in mid-1954. This may be regarded as the only works in the world where natural gas has been liquefied for the past six years and liq methane stored in bulk and re-gasified for transmission through trunk pipelines to gas consumers during peak-load periods. Furthermore, liq methane has been transported in road tank cars for consumption by industrial users beyond the range of gas utility distribution systems. Details are given of the layout and use of the Moscow LSR plant and the storage unit, and testing of storage performance and insulant quality are described. Full capacity of the plant is given as *ca* 70 metric tons/day of liq natural gas. Liquefaction costs are tabulated and recovery of "cold" during re-gasification is discussed. This article is to be continued. A. D. S.

448. Gas hydrates: a practical control method. Pt 3. L. E. Connealy. *Oil Gas J.*, 7.11.60, **58** (45), 173–81.—Methanol injection rate cannot be specified exactly for each 1 MMcf of gas because of variable conditions encountered but, as a rule of thumb, a minimum of 5 gal/MMcf gas on a lateral from 500 to 1000 ft long and 2–5 gal on shorter lengths of 3-inch lateral could be adopted. High quantities of methanol are usually required when the gas flow rate falls below the optimum value, and this condition must be carefully watched if hydrates are to be avoided. Turbulence at the tap or check valve can cause hydrate formation even though there is equilibrium between methanol and free water in the gas—injection of a few gallons of methanol at the valve will clear this. When freeing a hydrate block it is best to relieve pressure on both sides of the block to prevent an unsafe pressure differential.

1959–60 was Texas Eastern's most successful year—they had 60 fewer hydrate blocks to clear, and gas loss while clearing hydrates was one-half that of the previous winter.

Their success is attributed to advanced planning and starting injection before the hydrate point is reached. A. D. S.

449. New Fina depot at Fulham. Anon. *Fluid Handl.*, 1960, 290–1.—Description of depot for petrol, diesel oil, kerosine, and domestic fuels, supplied by barge from terminal at mouth of Thames. Total storage capacity 882,000 gal, approx half underground. W. A. M.

450. The reduction of pressure gradients in oil pipelines. M. E. Charles. *Canad. Min. metall. Bull.*, 1960, **53**, 483–7.—The effect of pumping water with the oil was studied in 1-inch and 2·5-inch pipes. The oil was a black crude with a sp gr of 0·90 and visc of 545–1200 cP according to the temp and shear rate in each test. With approx 50% of water stratified flow was achieved and the pressure gradient was reduced by a factor of at least 10. With smaller amounts of water or with turbulent flow water-in-oil emulsions formed—which is the most unfavourable condition. The possibility of commercial application is discussed. In a long line the oil and water would have to be separated at each pumping station. G. B.

451. Basin pipeline's preventive-maintenance programme. R. P. Thorn. *Oil Gas J.*, 21.11.60, **58** (47), 204–9.—For efficient and economical operation of a large electrified pipeline system, a definite programme for preventive maintenance is essential. It must have a schedule of inspection, testing, and repairs to warn of defective parts before breakdown or trouble occurs. A system of records must be kept to insure the carrying out of the programme and keeping supervisory personnel informed of the status of the electrical equipment. Spare parts are required for unforeseen breakdowns, and hard-to-get or long delivery items to prevent extended down-time. Electrical technicians must be well qualified and have a desire to improve equipment operating characteristics.
A. D. S.

452. Heavy cement coating solves soil condition problem. L. J. Moremen and J. R. Williams. *Petrol. Engr*, Nov 1960, **32** (12), D35.—Problems encountered in building a recent California coastal pipeline included the danger of swift floods which could undercut sections of the line and turn the terrain into a fluid mud. The line was built of thick-walled pipe of high beam strength coated with 4–6 inches of reinforced concrete to provide negative buoyancy in the mud. The method of applying this heavy coating is dealt with in some detail. G. D. F.

453. Transwestern goes all out for automation. F. H. Love. *Petrol. Engr*, Sept 1960, **32** (10), D20.—This very long paper deals with various points of interest in connexion with the Transwestern Pipeline Co's 2013-mile line from Texas to California. Details of the route, construction, and compressor stations are given. The control centre, with its computers, telemetering equipment, automatic safely controls, etc., is described. G. D. F.

454. Control of surges in liquid pipelines. Anon. *Petrol. Engr*, Sept 1960, **32** (10), D60.—A method is given for calculating the magnitude of pressure surges in pipelines. The velocity of the pressure wave front is determined from a graph which is provided. Protective devices are considered for centrifugal and reciprocating pump stations. Finally, it is shown that air pockets trapped in pipelines may lead to dangerous surges. G. D. F.

455. Casing promotes corrosion at crossings instead of providing protection. R. J. Kuhn. *Oil Gas J.*, 5.12.60, **58** (49), 103–5.—It has been long standing practice to encase many pipelines crossing railroads and highways, and many instances this has been at the request of the facility being crossed. It is shown that such casings can in fact cause corrosion, due to electrolytic discharge of current from the metallic surface. Even when the carrier pipe inside the casing is cathodically protected, corrosion will occur unless the casing is essentially bare and the annular space between the pipes is filled with an electrolyte. Probably the most important single factor causing corrosion of a carrier pipe is the accidental short-circuiting of the casing to the carrier. Nowadays, such crossings can be designed using uncased pipe which is structurally strong and which will not deflect excessively under a combination of internal pressures and external loads.
A. D. S.

456. The Oil India pipeline. Anon. *Petrol. Times*, 16.12.60, **64**, 843–57.—This pipeline will carry 2·75 million tons pa of crude from oilfields in the Nahorkatiya, Hugrijan, and Moran areas of Upper Assam, a total distance of 720 miles, to two new refineries, one in Assam and the other in Bihar. Laying of this pipeline, which is the most technically advanced single system of its size in the world, commenced on 15 Nov 1960.

Nahorkatiya crude has a pour point of *ca* 90° F, and the pipeline was designed for a pressure drop in the 16-inch section of only 12 psi/mile, ensuring that even after shutdown, pumping operations can be resumed without difficulty.

The pipeline route is detailed and involves 78 river crossings, with eight large rivers varying in width from 100 to 1000 ft, depending on the season. The Brahmaputra river crossing receives special mention because of the particular problems involved. A multiple-span suspension bridge, 4800 ft long, is being constructed for this crossing.

The telecommunications, telemetering, telecontrol, and instrumentation are described in detail and represent the latest and most advanced techniques, some of which have never been employed in any pipeline system before.

Survey and demarcation of the entire route have been largely completed and the 16-inch pipe lies stockpiled at various points along the 270 miles long leg of this line. Supplies of 14-inch pipe are being received and despatched to up-country stockpiles at various places on the route.
A. D. S.

457. European pipelines. F. C. Livingstone. *Petrol. Engr*, Nov 1960, **32** (12), D46.—Various completed and proposed pipelines in Europe are mentioned. Already completed are the Rotterdam–Rhine line and Wilhelmshaven to Cologne line. Under construction is the Marseilles–Karlsruhe line (470 miles, due to be completed at end of 1962). A proposed line from Genoa to Munich is also mentioned, together with various possible links between the lines. The effects of the pipelines on refinery siting, distribution, etc., are discussed. Several proposed British pipelines are also mentioned, together with Soviet pipeline activities in E Europe. G. D. F.

458. A common carrier pipeline for the U.K. Anon. *Petrol. Times*, 16.12.60, **64**, 841–2.—A new company, Trunk Pipelines Ltd, have laid a scheme before Parliament for a common carrier pipeline which will start in the Canvey Island area and run through London to Wandsworth and London Airport. A spur will branch off to Gulf Oils depot at Dagenham and to Purfleet, where Esso and Shell-Mex & B.P. have depots. A second spur will branch off to Fulham, where Petrofina has a depot, and go under the Thames to points S of the river. Although details of the dia and capacity of the line are not available, a figure of £1·5 million has been envisaged as the cost, and it is estimated that the project will take 12–18 months to complete. This is the first proposal in the U.K. for a common carrier line, but it xpected to be the forerunner of a much more ambitious cheme. A.D. S.

REFINERY OPERATIONS

REFINERIES AND AUXILIARY REFINERY PLANT

459. Heaters for petroleum and chemical processing. Anon. *Fluid Handl.*, 1960, 321–2.—Illustrated description of Gradiation heaters. Large number of small burners, requiring only 5% excess air, radiate heat to tubes containing process material; sections can be controlled independently to give temp gradient. Uses include dist, cracking, pyrolysis, and cat reactions. W. A. M.

460. Stop "hot process" foundation settlement. B. McClelland. *Petrol. Engr*, Sept 1960, **32** (10), C22.—When some soils are heated, *e.g.* by boiler houses, shrinkage occurs, with resultant settling. Four case histories are examined to show the depth to which heat penetrates, the degree of desiccation, and the slowness of the process. Theoretical temp distributions are derived, and methods of preventing desiccation settling are given. G. D. F.

461. How to design a multiple component partial condenser. D. J. Ward. *Petrol. Engr*, Oct 1960, **32** (11), C42.—The complications arising in the design of partial condensers for multi-component systems are outlined. Relationships suitable for either hand or machine computation are derived which do not involve trial and error mass and heat transfer calculations. A detailed example of the proposed method is given. G. D. F.

462. Petrochemicals still in building forefront. R. B. Bizal. *Oil Gas J.*, 5.12.60, **58** (49), 119–25.—A survey is given of petrochemical building programmes planned or under way. Current plant construction includes refinery, field processing, and petrochemical plant construction, and is presented by companies. Highlighting refinery construction is the first use of the Lomas unit and the Isocracking process. Among 25 field processing projects listed, the biggest news is the proposed 900-MMcfd plant at Bushton, Kansas, which will extract propane, butane, *iso*butane, ethane, and some natural gas. A. D. S.

463. Development of refinery engineering in Europe and the U.K. E. J. M. Tait. *Petroleum, Lond.*, 1960, **23**, 381.—The vast increase in refining operations in W Europe since the last war has led to the rapid development of refinery engineering. Various important changes in this period in the fields of design, construction, and maintenance are mentioned. G. D. F.

464. Design considerations for sectional heat exchangers. E. J. Skiba. *Petrol. Engr*, Oct 1960, **32** (11), C49.—The advantages of finned tubes for heat exchange purposes is outlined. Graphs are given showing the effect of various variables of fin efficiency. The advantages in mechanical design are also listed. Graphs are presented showing the approx costs of several styles of sectional heat exchangers. G. D. F.

465. Exchanger design. K. J. Bell. *Petrol. Engr*, Oct 1960, **32** (11), C26.—Various aspects of the University of Delaware research programme on baffles and shell-and-tube heat exchangers are dealt with, including: flow across tube banks, in the laminar, transitional, and turbulent regimes; baffled cyl heat exchangers, with no baffle leakage; and the effect of leakage. Numerous data and correlations are presented.

The application of this fundamental research to heat exchanger design is then shown. General design rules are laid down, and a very detailed worked example is given. There is a useful bibliography. G. D. F.

466. French refining capacity at 37·5 million tons. Anon. *Petroleum, Lond.*, 1960, **23**, 417.—A very brief article shows, by means of a map and table, the position, capacity, ownership, and 1959 production of the 14 refineries in operation in metropolitan France. G. D. F.

467. Rapid growth of German refining industry. Anon. *Petroleum, Lond.*, 1960, **23**, 413.—The increase in the consumption of oil in W Germany in recent years, together with the growth of the petrochemical industry, is due to the increase in the number and capacity of refineries. The pipelines (Wilhelmshaven–Cologne, Rotterdam–Rhineland, and Marseilles–Karlsruhe) are mentioned, as well as the refineries fed by these lines. The capacities and other details of the refineries at Cologne, Gelsenkirche, Hamburg, Bremen, Emden, Karlsruhe, Gelsenberg are given briefly. Some forecasts of probable developments in Bavaria are made. Finally, there is a short section on the sources of crude and consumption of products. G. D. F.

468. Dinslaken refinery. Anon. *Petroleum, Lond.*, 1960, **23**, 463.—The first stage of the 4·4 million tons pa refinery of BP Benzin & Petroleum AG was opened on 20 Oct at Dinslaken in the Ruhr. Work on stage II is expected to be complete in 1961. The site is described, together with the process units already complete and those under construction. The effluent problem is mentioned. The utilities and facilities for storage, blending, etc., are also described. G. D. F.

469. Esso refinery—Milford Haven. D. V. Newbold and E. K. Roper. *Petrol Times*, 4.11.60, **64**, 754–8.—The Milford Haven refinery is of the hydroskimming type, with a throughput of 100,000 bd, and will produce high quality motor spirits, jet fuels, gas and diesel fuels, as well as various grades of fuel oils. The refinery layout and the site investigation and preparation are described, an area of 350 acres having been developed initially.

The major process units are a 100,000-bd crude dist unit, a 16,500 bd gas oil Hydrofiner, a 14,900-bd cat reformer, and a copper chloride sweetening unit. The instrumentation, marine terminal, tankage, product loading, utilities, effluent disposal, and safety facilities are described. One of the unique features of the refinery is the exclusive use of air cooling for the process units. A. D. S.

470. Milford Haven on stream. Anon. *Petroleum, Lond.*, 1960, **23**, 453.—The Milford Haven refinery in S Wales was officially opened on 3 Nov. The preliminary work and the plant in general are described in some detail. This refinery is the first in the U.K. to be entirely air-cooled. Instrumentation, safety precautions, effluent disposal, etc., are mentioned also. G. D. F.

471. Milford Haven equipment review. Anon. *Petroleum, Lond.*, 1960, **23**, 459.—Various items of the equipment and services supplied for the Milford Haven refinery are described, including storage tanks, flameproof equipment, thermal insulation, valves, pipework, fire protection, bituminous coatings, boiler feed-water treatment system, communications, alarm equipment, recorders, hoses, pumps, lighting, pipe supports, site buildings, etc. G. D. F.

DISTILLATION

472. Distillation in view of modern developments. Pt 2, Chap 2d. Binary distillation. K. F. Gordon and J. A. Davies. *Petrol. Engr*, Sept 1960, **32** (10), C40.—This part deals with the calculation (by the McCabe–Thiele and Ponchon–Savarit methods) of the number of ideal dist stages, with the feed at

optimum and non-optimum positions, and in the cases of charge reflux and charge reboiled dist. G. D. F.

CRACKING

473. What you should know about catalytic cracking. I. Kinetics, catalysis. J. F. Crocoll and R. D. JaQuay. *Petrol. Engr*, Nov 1960, **32** (12), C24.—This part deals first with the kinetics of cat cracking. Among the aspects considered are the overall conversion rate, deactivation by selective adsorption, the effects of temp and the presence of saturated and aromatic cpds, and the possibility of avoiding unwanted effects by using lower conversions with a recycle system. Secondly, catalysis itself is considered. The theory of cat cracking is dealt with; there are also sections dealing with the acidity, activity, and chemistry of the cat, changes of cat during use, and the effects of a number of different types of cat contaminants. G. D. F.

474. Catalytic cracking process design. W. C. Chatman, C. W. Chen, and G. T. Atkins. *Petrol. Engr*, Nov 1960, **32** (12), C37.—The design of dense phase reactors, transport reactors, multiple reactors, and regenerators is considered briefly. The pressure balance is dealt with, and heat balances are considered under various headings. Mention is also made of the utilities required. G. D. F.

475. Moving bed catalytic cracking. 1. General process design relationships. A. W. Hoge *et al.* *Petrol. Engr*, Nov 1960, **32** (12), C44.—The development of the moving bed cat cracking process is outlined, and the HB Houdriflow process is described in some detail. The remainder of this part deals with process design methods, where the fundamentals of gravity solids flow, the fundamentals of vapour flow in solids beds, and heat transfer in moving beds are considered. G. D. F.

476. Characterization and preparation of catalytic cracking feedstocks. W. J. Service. *Petrol. Engr*, Nov 1960, **32** (12), C31.—The cracking processes and products for the main classes of hydrocarbons are mentioned. The picture of petroleum composition afforded by mass spectrometric techniques gives some basis for the simplified correlations (which are outlined) used for defining hydrocarbon-type distribution in cat cracking feeds. The effects of various non-hydrocarbon contaminants on the cracking process are given briefly. Finally, various methods of preparing the feedstocks are considered, including dist, coking, deasphalting, liq–liq extraction, hydrotreating, etc. There are numerous refs. G. D. F.

477. Manufacture and use of some catalysts in the petroleum and petrochemical industries. Platinum reforming catalysts. H. Connor. *Chem. & Ind.*, 1960, 1454–72.—Detailed review of Pt cat reforming, including chem reactions, commercial processes for high ON gasoline and aromatics production, and cat activation, deactivation, and regeneration. Use of non-Pt noble metal reforming cat is also considered. Principles involved in manufacture of Pt reforming cat are outlined and patent literature surveyed. Recovery of Pt from spent cat is discussed. Extensive bibliography (280 refs). W. A. M.

478. Manufacture and use of some catalysts in the petroleum and petrochemical industries. Anon. *Chem. & Ind.*, 1960, 1589–93.—Discussion of papers covered by Abs **301, 477**, 1961. W. A. M.

POLYMERIZATION

479. Chemical nature of products obtained from low-molecular weight olefins with phosphoric acid and aluminium chloride. (In German.) E. Terres *et al.* *Erdöl u. Kohle*, 1959, **12**, 47–671, 547–50, 614–19.—Pt I. Ethylene polymerization with aluminium chloride without and with metallic aluminium addition. Pt II. Propylene polymerization with aluminium chloride. Polymerization of *n*-butene-1 and *n*-pentene-1 with phosphoric acid. Pt III. Polymerization of *iso*butylene or *iso*-octene-1 with aluminium chloride and hydrochloric acid–ether–aluminium chloride-complex.—Pt I deals with C_2H_4 polymerization with $AlCl_3$ alone and with 25 wt % metallic Al addition. A typical conjunct polymerization occurs in which the main products are 2-methyl and 2,3-dimethyl paraffins and alkylated *cyclo*paraffins. The proportion of unsaturated cpds is very small. Al addition effects on the polymerization reaction velocity reduction, lowering of the paraffinic portion, and raising of the olefin cont. It is inferred—from the structure of both polymerizates and from comparison of reaction velocities—that cyclization and paraffin formation are coupled, and are effected by transfer of H-anions from primarily formed higher-mol polymers to lower-mol members of the growing reaction chain. Influence of Al addition is seen in the basis of this conception, in checking H-anion transfer. Pt II deals with polymerization of propylene, *n*-butene-1, and *n*-pentene-1. C_3H_6 polymerization with $AlCl_3$ differs from that with H_3PO_4 by another mol magnitude distribution, whose centre of gravity lies above C_{24}, and by a higher branching degree. In the homologous series resulting as main product the trimer was identified as 3-*iso*propylhexene-2. For the C_{12} fraction 3-*iso*propyl-4-ethyl-structure is made probable by regularity and uv spectrum. For formation of this structure it is assumed that—from the dimers obtained in the first reaction stage—both with $AlCl_3$ and H_3PO_4—the $AlCl_3$ series arises through a double bond isomerization. Polymerization of *n*-butene-1 with H_3PO_4 yields no essentially new information. In contrast to C_3H_6, isomerization of the monomers is possible before the first polymerization stage. Besides, mol wt of an intermediate fraction C_6–C_{12} show some polymer cracking. Partial conversion of the monomers to *n*-butene-2 explains the formation of the main components 3,4-dimethylhexene-1 and -2, the main components of the C_6-fraction. Occurrences observed with *n*-butene-1 are intensified in *n*-pentene-1 polymerization with H_3PO_4. Fractions with C–No < 5 and intermediate fractions C_6–C_9 and C_{16}–C_{19} indicate strong cracking. In the C_{10} fraction 12 individual cpds obtained by chem dissociation were identified by round filter chromatography, whose structure indicates a conjunct polymerization. Comparison of polymerization of propylene, *n*-butene-1, and *n*-pentene-1 with H_3PO_4 at temp 160°–200° C and 40–70 atm original pressure shows that—under these conditions—with increasing chain length, the proportion of side reactions increases parallel with chain length. Pt III. In *iso*butylene polymerization with $AlCl_3$ dependence of reaction velocity and mol size distribution in temp range 30°–90° C is established. Dimer, trimer, and tetramer structures were identified from chem constitution. C_8-fraction consists of two double-bond-isomers, C_{12}-fraction of two isomeric pairs differing in their C frame. The tetrameric fraction consists of two double-bond-isomers and a combination thereof with different C frame. Constitution determination shows that fractions C_6–C_{16} obtained with $AlCl_3$ in nitromethane under normal pressure in temp range 30°–90° C have the same structure as those obtained with H_3PO_4 and H_2SO_4. Cat effect of $AlCl_3$ was modified by formation of complex $H[AlCl_4] \cdot 2(C_2H_5)_2O$. Polymerization with this complex in nitromethane yielded a polymerizate in temp range 30°–70° C mainly represented by C_{12}-fraction. Acid and $AlCl_3$ give identical polymerizate structures. Quant relation of the structures varies; C_{12}-fraction consists up to 67% of a 4-methene structure. Results indicate that polymerization occurs in all cases over a cationic mechanism, the complex cat selectivity regarding proton splitting off, leading to stabilization. Individual stages of *iso*-octene-1 polymerization with $AlCl_3$ and with the complex

were investigated under the same conditions as *iso*butylene. In polymerization with $AlCl_3$ 50% of polymerizate consisted of a C_{16}-fraction, with the same structure as that obtained in *iso*butylene polymerization. Polymerization with the complex gave 95% C_{16}-fraction. Apart from small impurities one structure only was present, namely, 2,2,6,6,8,8-hexamethyl-4-methene-nonane. Therefrom is concluded the possibility, by gradation of cat activity and reaction conditions, of directing olefin polymerization in a preferred direction as regards degree and structure. 28 refs. R. T.

CHEMICAL AND PHYSICAL REFINING

480. Partial removal of H_2S from crude oil by stripping with natural gas. T. R. Shipster. *Inst. Petrol. Rev.*, 1960, **14**, 393–5.—The unit installed consists of two columns, each with a max design capacity of 105,000 bd of crude oil. These columns contain 24 four-pass bubble-cap trays and the crude oil is delivered to the top tray. The sweet gas which is available at pressure enters under the bottom tray and after stripping passes through a mist extractor to a flare. With a column efficiency of four theoretical plates, *ca* 95% of the H_2S is stripped. Although any sweet gas can be used, if other considerations, such as vapour pressure, gravity, and light end content of the sweetened crude have to be taken into account, a gas which is best able to meet such requirements must be used. It is possible to use a gas containing H_2S, and an example is given of a 6000-bd unit which removes 75–80% H_2S using a gas containing *ca* 0·9% H_2S. A. D. S.

SPECIAL PROCESSES

481. New gas process plant incorporates new features. J. A. Sutherland, W. M. Hathaway, and P. W. Eatman. *Oil Gas J.*, 28.11.60, **58** (48), 64–6.—This new 650-MMcfd gas processing plant operated by Union–Texas Natural Gas Corpn recovers 90% + of the propane in the inlet gas. It has complete fractionation facilities for handling 316,000 gal of product/day and generates its own power. Centrifugal propane refrigeration compressors maintain the absorption section at −40° F. Total fuel consumption is less than 1% of the inlet-gas vol and gas-pressure loss through the plant is around 10 psi. The equipment is designed to allow plant expansion for future ethane recovery. A flow sheet of the plant is given. A. D. S.

482. Liquid recovery plants profit Pembina producers. H. C. Bozeman. *Oil Gas J.*, 7.11.60, **58** (45), 118–20.—Early in 1957 Pembina producers began planning a system to conserve 95% or more of the casing-head gas, then currently flared. Eight conservation areas, covering some 207,000 acres, have their own complete gas recovery unit. The wet gas to these satellite units is collected at low pressure from the tank batteries. The satellite units compress and dehydrate the gas, extract the liq, and deliver the residue gas to the utility pipeline. The recovered gas liq are piped to the central fractionation plant, where products such as propane, *n*-butane, *iso*butane, and natural gasoline are obtained.

This $20 million project involving 76 different producers saves annually *ca* 26 billion cu ft of natural gas for marketing or re-injection and produces 60 million gal of marketable gas liq. A. D. S.

483. How Gulf makes million pounds per day of merchant ethylene. Anon. *Oil Gas J.*, 21.11.60, **58** (47), 198–202.—The major steps involved in the production and recovery of ethylene include pyrolysis, quench, compression and recovery, and purification. Product quality is high, and recently the purity of the entire production has reached over 99·8%. For storage, a high pressure gas storage system in salt domes was selected, water being removed from the gas when it is returned to the pipeline by dehydration equipment at the storage site. The distribution system is made up of *ca* 147 miles of 6- and 8-inch pipe, operation being controlled from one point. Loss of ethylene from the system has averaged less than 0·5% of all the product handled. A. D. S.

METERING AND CONTROL

484. Developments in salt-velocity flow measurement. L. Young and G. Wilson. *La Houille Blanche*, 1960, **15**, 569–600.—Numerous experiments have been carried out on a lab scale on the salt-velocity flow measurement method, it is reported. The injection apparatus, detecting equipment, etc., are described. The results are evaluated, and there are careful comparisons of the tests. Full-scale field tests are also described. G. D. F.

485. Continuous infra-red analysis. Anon. *Petrol. Times*, 16.12.60, **64**, 860.—A continuous ir analyser, developed by Distillers Co Ltd, works on characteristic bands in the overtone region 1–3 μ. Although these bands are weaker than those in the fundamental region, it has the advantage that the path lengths became practicable, *i.e.* of the order of 1 cm. Brief details are given of the equipment and method of analysis, and the instrument is stated to be capable of detecting 0·005% water in acetone and suitable for accurate continuous measurement of water in acetic acid, alcohol, and other liq. The instrument may be used for controlling the reflux ratio of a dist column. A. D. S.

486. Quality control in the petroleum industry. Anon. *Petroleum, Lond.*, 1960, **23**, 472.—Reviews are given of three papers presented at a symposium on quality control held on 22 Sept in London by the Quality Control Division of Elliott Brothers (London) Ltd. The discussion on these papers is also reported. G. D. F.

487. Shipping volatiles with crude. P. R. Scott. *Petrol. Engr*, Oct 1960, **32** (11), D24.—Volatile material must be transported in pipelines as blends with crude material. The increased vapour pressure may lead to various difficulties, such as pump cavitation. Tests were carried out on a pipeline system using a vapour pressure recorder-controller for controlling the rate of injection of the volatile material. The recorder-controller is described, and the experimental operating experience is summarized. G. D. F.

488. World's biggest crude unit nears computer control. G. L. Farrar. *Oil Gas J.*, 14.11.60, **58** (46), 143–7.—An electronic computer is optimizing operation on the No. 12 pipe still at Standard's Whiting, Indiana, refinery. Every 4 minutes an IBM 704 computer reads 196 instruments, and every 20 minutes it types out orders that originate from 75,000 stored instructions. The results are used in adjusting 19 controllers as needed. Five process-monitoring instruments are incorporated to provide vital information for the computer programme. Early in 1961 full closed-loop control is expected, which will correspond to the time when this 140,000-brl unit is running as close to optimum as possible. A. D. S.

489. New initial cost favours turbine pipeline meter. W. W. Holt. *Oil Gas J.*, 28.11.60, **58** (48), 70–1.—A comparison of costs for a 10,000-brl/hr metering system favours the turbine meter as compared with either a single or a bank of positive displacement meters. The flow-rate of the turbine meter is good from 100% down to at least 40% of rated

capacity. It will pass all normal pipeline dirt without difficulty, but larger objects can damage the blades if precautions are not taken. Its accuracy and repeatability are excellent, but the same precautions, procedures, and techniques used for satisfactory positive displacement meter operation must be observed. A. D. S.

490. Computers: how effective for pipeline control. R. G. MacInerney. *Petrol. Engr*, Oct 1960, **32** (11), D38.—The applicability of computers for pipeline control is considered. The method of operation of control systems is described by means of diagram and sketches. Finally, the effect of computers on the design of pipelines is considered. G. D. F.

491. Controller computing. 2. G. Post. *Petrol. Engr*, Oct 1960, **32** (11), D29.—In this part the application to a pipeline problem of each of the three types of computer mentioned in Pt 1 is considered. The analogue type computer is applied to a compressor surge control problem, and the digital computer to a central dispatching system, which uses incremental digital computers as slave computers in unmanned stations. G. D. F.

PRODUCTS

CHEMISTRY AND PHYSICS

492. Determination of flame velocities in gaseous pre-detonation. G. J. Hecht *et al.* *Rev. Sci. Instrum.*, 1960, **31**, 1107–11.—The application of ionization gap (pin) probes to measure flame velocities during the development of detonation is described. The probe consists of a pair of concentric stainless steel cyl, mutually insulated, forming a plug which is threaded into the detonation tube, and in use it registers variations in the resistance of the gaseous mixture, determined by the state of ionization and ion mobility. Probe construction and circuit techniques are described which, despite the widely-varying character of the ionization signals in this region, yield timing precision of 2% or less for stoichiometric H_2/O_2 mixtures. The probe signal can be identified with the ionization levels encountered in the various waves generated during the development of detonation. In this manner it is possible to differentiate between shocks, flames, and detonation waves and to determine the axial flame velocity profile. H. C. E.

493. Liquid chromatographic separation of mixtures of polymers and mineral oils. P. I. Brewer. *Nature, Lond.*, 1960, **188**, 934.—Polymers dissolved in mineral oil can be separated chromatographically using vulcanized natural rubber latex as the stationary phase and a light liq paraffin hydrocarbon as the mobile phase. A column 21 mm dia and 82 cm long was packed with pieces of rubber of average size 15 mm². A blend of poly*iso*butylene in mineral oil was dissolved in heptane (0·25 g in 5 ml) and passed through the column at 10–15 ml/hr; and when all the sample had passed further solvent was added. Poly*iso*butylene was eluted first and mineral oil second: 98% of the blend was recovered.

The separation is presumably due to the swollen rubber acting as a mol sieve into which the relatively small mineral oil molecules are able to diffuse. H. C. E.

494. Second International Congress on Catalysis. W. E. Askey and H. Heinemann. *Petrol. Engr*, Nov 1960, **32** (12), C20.—The two authors review and discuss five of the most significant papers presented at the Second International Congress on Catalysis held in Paris in July 1960. G. D. F.

ANALYSIS AND TESTING

495. The use of tritium to study the solubility of water in hydrocarbon liquids. B. D. Caddock and P. L. Davies. *J. Inst. Petrol.*, 1960, **46**, 391–6.—A technique is described for measuring the solubility of water in hydrocarbon liq. It involves introducing a known amount of water vapour, tagged with HTO into an air stream, followed by equilibration of this air stream with the hydrocarbon under test. The water content is determined by measuring the activity of the hydrocarbon after equilibration. The apparatus, including the water and the hydrocarbon saturators and the tritium liq scintillation counter, are detailed and the experimental technique described. Results are presented for water solubility in benzene and toluene, and these systems are shown to obey Henry's law up to saturation. Total water solubilities obtained at 20° C with benzene and toluene are 52 and 46 mg/100 g respectively, and these values agree well with other published data. A. D. S.

496. Gulf's new 100-kV X-ray spectograph. V. W. Palen. *Oil Gas J.*, 21.11.60, **58** (47), 190–3.—Gulf employ a 60-kV and a new 100-kV X-ray spectograph for determining metals in oil samples. The 100-kV machine can detect metals down to 0·5 ppm and is about three times more sensitive than the 60-kV apparatus.

The 60-kV unit is used for analysing barium, calcium, zinc, and lead in lubricating oils and additives, whilst the 100-kV unit is used for determining nickel and vanadium in crudes and cracking cat.

Sample preparations, cells, and the operation of these units are described. A. D. S.

CRUDE OIL

497. Evaporation losses from crude oils. *Canad. Min. metall. Bull.*, 1960, **53**, 477–82.—Known methods of estimating evaporation loss have been examined. Only those based on change of composition determined by dist were considered to be worth further study. In the recommended procedure evaporated and unevaporated samples are each submitted to a Hempel dist. The change in the yield of bottom residues of equal API gravity is used to calculate the evaporation loss. G. B.

GAS

498. Gas cleaners: a qualitative analysis. N. W. Wiederhorn and A. W. Doyle. *Petrol. Engr*, Sept 1960, **32** (10), D49.—The operating principles of gas cleaners of the following types are dealt with: filter type, centrifugal, oil bath scrubbers (conventional and rotating member). Experimental results on the efficiencies of eight cleaners are reported, together with data on pressure drops and oil losses. The phenomenon of negative oil loss is dealt with. G. D. F.

499. Reforming natural gas at Whitby. Anon. *Petroleum, Lond.*, 1960, **23**, 429.—The wells supplying natural gas to the town of Whitby are described. The well-head equipment, pipeline, and the flow and pressure-control systems are described. Finally, the reforming plant, in which the natural gas is reformed to approx in quality to coal gas, is described in some detail. The initial and reformed gas compositions are given. G. D. F.

500. Changes in physical properties of natural gas mixtures through conditioning for pipeline specifications. G. A. van Wielingen. *Canad. Min. metall. Bull.*, 1960, **53**, 569–77.—

Specifications for the quality of natural gas for sale in Alberta are given. Equations, graphs, and a step-by-step procedure are presented for calculating from the analysis of the crude gas the nature and extent of treatment required to meet the specification and the yield of saleable gas. Emphasis is placed on hydrocarbon dew points, heating value, and losses.
G. B.

501. Natural gas supply in Argentina. Various. *Petroleum, Lond.*, 1960, **23**, 434.—A summary is given of five papers dealing with the change-over from coal gas to natural gas in Argentina which were presented in Buenos Aires in Sept 1959.
G. D. F.

502. British source of natural gas. R. J. Sarjant. *Nature, Lond.*, 1960, **188**, 373.—Two wells in the N Riding of Yorkshire, England, draw gas at 2000 psi from limestone layers 4000–5000 ft deep at a flow rate of up to 4·5 m ft³/day. The gas contains 93–94% methane and is sulphur-free; its cal val is 1000 Btu/ft³.

Part of the gas is reformed over a Ni cat at 1100° C, and the product is mixed with natural gas and flue gases from the furnaces to give a product with cal val 500 Btu/ft³.
H. C. E.

ENGINE FUELS

503. Trials of a small bore diesel engine on heavy fuel. Anon. *Gas Oil Pwr*, 1960, **55**, 254–6.—A single-cyl two-stroke crosshead Smit–Bolnes engine with cyl of bore 300 mm and stroke 550 mm, developing 125 bhp at 275 rev/min, was run on heavy fuel (3150 sec Red I 100° F) having a S content of 2·6% and ash content of 0·04%. The fuel was preheated so that its temp at the fuel pump was 230° F; a normal single-hole injector was used.

The fuel consumption was 0·425 lb/bhp/hr, compared with a value of 0·40 for gas oil, but the higher figure is explained by the lower cal val of the heavy fuel. Injection began later and ended earlier with gas oil as compared with heavy fuel, and as a result smoother running was obtained with the latter. After 100 hr running all rings were free and the average wt loss was 1 g. After test the cyl was generally clean, except for a slight deposit on the exhaust valve.
H. C. E.

504. Kerosine—IATA deplores Lord Brabazon's stand. Anon. *Aeroplane*, 30.12.60, 847.—The fire hazards after accidents to turbine-driven aircraft when using JP4 or kerosine are the subject of letters exchanged between Lord Brabazon and Sir W. P. Hildred (Director-General of the International Air Transport Association). Sir W. P. Hildred suggests that complicated technical matters are best handled by technically qualified people. Lord Brabazon states that JP4 is more prone to "flash into a bonfire," and is therefore a greater hazard, but is used because it is cheaper. These letters were first published in *The Listener*, 22 Dec 1960.
A. T.

505. Kerosine—Lord Brabazon replies to his critics. Anon. *Aeroplane*, 6.1.60, 5.—Further correspondence on the use of JP4 and kerosine between Lord Brabazon and Sir William Hildred is published, together with a statement by J. T. Dyment (chief engineer of TCA). Mr Dyment accepts that JP4 is more likely to ignite than kerosine if there is a spark above it, but suggests that the major cause of fire after an accident is from engine oil or hydraulic fluid coming into contact with hot metal. In this respect kerosine ignites 400° lower than JP4. Other factors taken into consideration are: (1) following a flame-out, re-starting is easier with JP4; (2) the engine is hotter with kerosine, which affects reliability of the engine; (3) kerosine retains suspended particles longer; (4) JP4 produces an explosive mixture only through a very narrow range of air–fuel mixtures; (5) kerosine may be prone to static electricity hazard; (6) smoke generation is greater with kerosine.
A. T.

GAS OIL AND FUEL OIL

506. The effect of operating conditions on the performance of different types of oil burners. L. E. Reed and S. C. Wallin. *J. Inst. Fuel*, 1961, **34**, 26–36.—A test rig was designed for assessing the performance of five different types of oil burner. The results of the tests are discussed in terms of the turn-down ratio, flame characteristics, heat to cooling water, and products of combustion. A 950-sec heavy fuel oil, of 2·8% S content and 0·04% ash, was used throughout the test programme. It was found that all the burners produced solid material, some of which would be emitted with the flue gases. The quantity produced varied with the type of atomization employed and the quantity of excess air supplied to the burner. Most of the burners produced the min quantity of solids when *ca* 30–40% excess air was used. This solid material was acidic, its acidity becoming less as the excess air was reduced to zero. The max heat was transferred to the water when the min quantity of excess air was used.
A. D. S.

507. Techniques employed in a study of the properties of flue gases from large oil-fired boilers. J. Stein, B. G. S. Taylor, and G. R. Wade. *J. Inst. Fuel*, 1961, **34**, 8–16.—Equipment and instrumentation are described for measurement of metal corrosion, SO_2 and SO_3 content of the flue gas, and the flue-gas solids burden, which allow a rapid assessment of boiler performance. The corrosion probe is lightweight in construction and the assembly is readily portable. Measurements can be carried out at two temp levels during one exposure, and a complete corrosion profile can be obtained in two working days. An automatic analyser was used for determining the SO_3 content of flue gases and had a higher accuracy than the manual method—standard deviation of a single reading is equivalent to 1·2 ppm SO_3. With this instrument it was possible to follow more closely changes in SO_3 content of flue gases as boiler operating conditions were altered. The sampling probe for measuring flue-gas solids employs a filter consisting of a stainless steel gauze into which is fitted a thimble of glass wool. Probes of different length can be used so that a traverse can be made across larger stacks.
A. D. S.

LUBRICANTS

508. Why engine lubrication fails. Pt I. O. H. Moore. *Oil Gas J.*, 5.12.60, **58** (49), 132–4.—Lubrication studies of IC engines show that piston ring and cyl wear vary with no definite pattern. Erratic oil delivery is blamed as the cause of the irregular wear patterns and tests with standard lubricator reservoirs, chain-driven at constant rev/min, gave the following results. The delivery rate/pump varied as much as 70%; equal charges in drops/minute did not result in equal changes in pump output; and variations were neither consistently higher or lower than the average. Although vacuum pumps have a more accurate delivery rate than pumps with sight feeds on the discharge side, these types of pumps continue to give trouble in the field.
A. D. S.

509. Gear oil testing in the gear bracing test stand. Position of the experience. (In German.) G. Niemann, H. Rettig, and G. Lechner. *Erdöl u. Kohle*, 1959, **12**, 472–80.—Experiences reported at a meeting in the research station of the tech high school, Munich, 10–12 Sept 1958 are presented. Execution and evaluation of FZG-gear-oil tests are discussed. Properties, insertion ranges of the tests, execution and evalua-

tion, special measures for confining scattering range, application of special tests, transfer of test results to definite operational problems, and comparability with other gear tests are described. 24 refs. R. T.

SPECIAL HYDROCARBON PRODUCTS

510. Draft of new edition of VDE 0370/ . . . 60. Specifications for transformer and switch oils. (In German.) L. Maurer. *Elektrotech. Z.* (*A*), 1960, **81**, 870–1.—Discussion of proposals, which represent tightening of requirements and include n_D; Ag test for corrosive S; fixed rate (3 kV/sec) of voltage rise in elect strength test; dielectric loss angle and resistivity. Baader 48-hr aging test now considered inadequate and extended durations recommended, 28 days for new types of oils, three-day acceptance test for known types; recognition of IEC aging test. Visc at −30° C reduced to 1800 cS, open flash reduced by 5° C, Sk val reduced to 4%. V. B.

511. Influence of aging on the characteristics of oil-filled cable dielectric. P. Gazzana-Priaroggia, G. L. Palandri, and U. A. Pelagatti. *Proc. IEE*, 1961, **108A**, Paper No. 3348 S, 13 pp.—Study of five cables, 60–230 kV, four single-core, one three-core, laid 1931–43. Examination of oils from cables did not yield any useful information (acidity 0·05–0·5, p.f./100° C, 0·03–0·09). Lab tests done on two cable components, oil and paper, separately and together and in presence of metals (Cu, tinned Cu, Al, Pb, mild steel, only Cu had appreciable effect). Oil tests were visc. acidity, p.f., on degassed oils in absence of air and moisture. New test oil had: sp gr 0·89, open flash 155° C, an pt, 75° C, visc 27 cS/20° C, 8 cS/50° C, pour −45° C, p.f./100° C 0·001, H_2 absorption (80° C, 16 kV, 300 min, Pirelli method) 1·3 ml. Tests at 90°–140° C for up to four years. Oil alone showed no change after 180 days, but in presence of paper, acidity rose, due to degradation of paper. Addition of organic acids raised p.f. only slightly, but heating with Cu greatly increased p.f., due to traces of Cu soaps (0·02% Cu oleate, equivalent to acidity $\ll$ 0·03, increased p.f. 50 times). Oil with Cu passivator (0·05% disalicylidene-ethylenediamine) showed no change after heating with Cu. Tests also reported on cable models and experimental cables. Concluded that paper is component most affected by temp. V. B.

DERIVED CHEMICAL PRODUCTS

512. The effect of carbon number on the alkylation behaviour of a 150°–250° C cut from full range propylene polymer. E. L. Bertrand and N. J. H. Small. *J. Inst. Petrol.*, 1960, **46**, 397–402.—In a study of carbon number distribution and alkylation behaviour of propylene polymer fractions boiling in the range 150°–250° C, carbon numbers were determined by quantitative hydrogenation. Lab alkylation tests were developed to assess the effect of carbon number on alkylate yield and cat consumption. It was concluded that C_{10} and C_{11} olefins alkylated readily to give a product boiling in the range 275°–295° C. C_{12} olefins were located in a polymer fraction boiling 186°–215° C and gave an alkylation product boiling in the range 295°–315° C. Alkylation properties deteriorated rapidly when the carbon number exceeded C_{12}, and polymer boiling above 215° C gave decreased alkylate yields and appeared to be mainly responsible for high cat consumption. A. D. S.

513. Heterogeneous catalysis in hydroformylation. C. A. Aldridge and H. B. Jonassen. *Nature, Lond.*, 1960, **188**, 404.—The evidence for heterogeneous *vis-à-vis* homogeneous catalysis in the hydroformylation (OXO) reaction is reviewed. It is concluded that since the cat surface is in dynamic equilibrium, the most suitable poison for it would be a heavy metal, which would enter the solid phase and inhibit hydrogen reactions by filling the *d*-band holes with the outer electrons of the metal.

The OXO reaction of heptenes over a Co cat at 177° C was studied, and the oil-sol ionic salts of Pb^{2+}, Hg^{2+}, Tl^{3+}, and Bi^{3+} were added as poisons. It was found that all except Tl were effective. Since the oxidn–reduction potential of Tl is such that, in the presence of Co, it is reduced only to Tl^{+}, whereas the other metallic ions are reduced to the metal, the ineffectiveness of Tl^{3+} is explained.

It is concluded that hydrogenation in the OXO reaction proceeds via a heterogeneous mechanism in which Co is the cat. H. C. E.

514. Survey of the chemical utilization of propylene. P. W. Sherwood. *Industr. Chem.*, 1960, **36**, 497–502, 542–6, 595–8.—C_3H_6 is a by-product of thermal or cat cracking of petroleum stocks to make gasoline and of thermal cracking of C_3H_8 and higher hydrocarbons to produce C_2H_4. Commercially important chem reactions of C_3H_6 are hydration, alkylation, oxidn, chlorination, chlorohydrination, OXO conversion, polymerization, and ammonolysis. Details of industrial processes and economics are given. Main products are Me_2CO, glycerol, propylene oxide, propylene glycol, OXO alcohols and aldehydes, nonene, dodecene, polypropylene, and acrylonitrile. 18 refs. W. A. M.

515. Cross fertilization of petroleum and chemical industry techniques through heavy organic chemicals. R. Holroyd. *Chem. & Ind.*, 1960, 1580–4.—Philosophies and general outlooks of petroleum and heavy org chem industries are shown to be historically different. Wartime and post-war developments have brought about a fusion of personnel and techniques, but production of heavy org chem, although now largely dependent on petroleum for raw materials, remains distinctive in its outlook from the petroleum industry. W. A. M.

516. Developments at Carrington. Anon. *Industr. Chem.*, 1960, **36**, 587–9.—Brief description of Shell's Carrington installation for production of olefins, aromatics, and their derivatives by cracking naphtha. W. A. M.

CORROSION

517. Rubber-lined pipework. Anon. *Petroleum, Lond.*, 1960, **23**, 387.—A number of rubber linings suitable for handling widely different materials are mentioned briefly. Uses of rubber-lined pipes in the refinery are mentioned. Finally, the application, examination, and testing of the lining are considered. G. D. F.

518. Protective coatings on well casing. W. R. Lambert. *Petrol. Engr*, Sept 1960, **32** (10), B53.—It is shown that corrosion of well casings may occur as a result of galvanic action, sulphate-reducing bacteria, chemical action, or stray currents. These are dealt with in turn. Downhole tests are reported on 11 coatings on a 8⅝-inch casing set at 2536 ft. The epoxy resins appear to be the most effective of the coatings tested. Some other methods of casing protection are considered briefly. G. D. F.

519. Protective coatings for corrosion control in production operations. R. M. Robinson. *J. Petrol. Tech.*, Oct 1960, **12** (10), 20–4.—Sometimes cost studies do not justify corrosion control; yet control may be required for continuously safe operation. The range of environments involved must be

considered. Suitable shapes may reduce coating problems. The possibility of renewal is of importance, as are surface preparation and coating application.

Offshore platforms are costly and may be required to stand for 20–40 years. Hence extensive corrosion controls are justified. For submerged parts cathodic protection has proved most practical and economical. Welded economy monel shielding has been effective in the splash zone, and a zinc silicate coating followed by vinyl film for exposed parts. Bituminous paint and anti-fouling coating have been used on floating equipment. Zinc silicate has been applied to production equipment; there may be a light coloured overcoat. Galvanizing has proved satisfactory inside tanks holding sour crude, but various resins are in use. Chlorinated rubber is suitable for tank tops. Cathodic protection has been used for "hot spots" in pipelines, and coal tar coating is most common. Submerged pipes are yard coated, the joints being dealt with during installation. Polyvinyl type coat with solvent-type adhesive is promising. A concrete coating for weight may be added to large pipes. Internal coatings have been used to control corrosion and paraffin deposition, and improve throughput. Casing has been externally coated in corrosive zones, with or without cathodic protection. G. D. H.

520. Soil corrosion of oil gas gathering lines in Alberta. R. G. Powell and G. G. Mainland. *Canad. Min. metall. Bull.*, 1960, **53**, 713–17.—The causes of soil corrosion and the methods of detecting and reducing it are outlined. The economics of protection are discussed in the light of experience with congested, unprotected lines in the Leduc field. For extended periods a combination of wrapping and cathodic protection is recommended. G. B.

SAFETY PRECAUTIONS

521. Progress Review No. 48. Air pollution. A. Marsh. *J. Inst. Fuel*, 1960, **33**, 609–15.—This review outlines the present situation and surveys the progress made since 1960, mainly from the background of the Report of the Beaver Cttee and the Clean Air Act, 1956. The measurement of air pollution is briefly discussed, with special mention of the studies of concentration of smoke suspended in the atmosphere, which have been made possible by the large number of smoke filters in use. The effects of air pollution on health are considered, and the principles of the Clean Air Act are enumerated. Progress under this Act is considered in terms of industrial smoke, grit and dust, chimney heights, other industrial pollution, and domestic smoke prevention, and as a result of a detailed inquiry it can be concluded that the Act is proving workable and successful.

Smoke and fumes from road vehicles are not controlled under the Clean Air Act, and are not a responsibility of local authorities. They are controlled under the Road Traffic Act, and the law, which is difficult to enforce, is administered by the police. Finally, sulphur gases emitted in chimney gases are considered and the international problem reviewed.

A. D. S.

522. New technique contains explosions. Anon. *Oil Gas J.*, 28.11.60, **58** (48), 68–9.—Explosion blasts are made harmless by a combination of actions which include suppression by envelopment of the explosion with water or bromochloromethane; venting by opening a path to atmosphere for controlled relief of pressure; advance inerting by suppressant in areas remote from the explosion source; isolation by blocking the explosion from other areas and automatic shut-down of the plant or equipment. Application of this system to a storage tank is shown diagrammatically, and still photographs demonstrate how explosions can be snuffed out in times of the order of 50 millisec. A. D. S.

523. Petroleum explosions. Anon. *Petrol. Times*, 16.12.60, **64**, 842.—The 84th annual report of HM Inspector of Explosives, covering the year ended 31 Dec 1959, shows that 64 accidents involving petroleum spirit and mixtures were reported during the year, as a result of which nine persons died. These figures compare with 58 accidents involving six deaths in the previous year. Particulars of all the incidents are given in the report which is available from HM Stationery Office. An appendix gives details of petroleum tank wagons approved in 1959. A. D. S.

ECONOMICS AND MARKETING

524. World tanker statistics third quarter 1960. Anon. *Inst. Petrol. Rev.*, 1960, **14**, 413–14.—251 oil tankers, totalling 4,035,364 gross tons, were under construction in the world at the end of the third quarter of 1960. Oil tankers accounted for 45·8% of all merchant shipping, but compared with the previous quarter actual tonnage fell by 323,249 tons. Britain led in tankers under construction, with Sweden in second and Italy in third place. Tabulated details are given of registrations, tankers under construction, and launchings during this quarter. A. D. S.

525. Cost cutting in the oil industry. Anon. *Oil Gas J.*, 14.11.60, **58** (46), 131–42.—The oil and gas industry, supplying more than 65% of all energy consumed in the U.S.A., has been progressing at a rapid pace. Now the industry has overshot the mark, and cost cutting is one of the main expedients in correcting this situation. One method of cost cutting is retrenchment, but a more positive solution is that of improving efficiency. This is applied to exploration, with emphasis on smaller crews, better information exchange, and wide well spacing, and to drilling with reference to a better use of equipment, multiple completions, slim-hole drilling, neutralizing crooked holes, lighter, cheaper, and more portable rigs, fewer and faster round trips, and turnkey drilling contracts. The producer, in looking for ways of cutting cost, will have the following paths open to him—more secondary recovery, more labour-saving automatic equipment and contracting lease work. Reduction of natural gas field processing costs is being mainly achieved by automation, whilst the lowering of pipelining costs lies in controlling capital expenditures—higher strength pipe is a most promising area for cost cutting. The refiner has taken the only recourse possible, namely, a gradual reduction of payrolls. Automation is also playing an important part, and maintenance costs are being reduced by use of more corrosion and abrasion-resistant materials, and of better temp control. Finally, public and government relations with the industry are considered.

A. D. S.

526. Some legal and engineering problems concerning unitization of oil and gas producing properties. D. W. McFarlane. *Canad. Min metall. Bull.*, 1960, **53**, 524–8.—Some of the factors, such as well productivity, cost of existing investment, relative values of oil and gas, which must be considered in arriving at an equitable unitization agreement, and the legal arguments and decisions arising from them are discussed and illustrated by reference to decisions made under the Saskatchewan Oil and Gas Conservation Act. G. B.

MISCELLANEOUS

527. Combustion research. Anon. *Petroleum, Lond.*, 1960, **23,** 475.—Some of the equipment and current research work on combustion problems at the BP Combustion Research Laboratory and the new Shell Combustion Laboratory are described. G. D. F.

528. Water in the petroleum industry. Anon. *Petroleum, Lond.*, 1960, **23,** 477.—The vapour-compression method of producing potable water from raw water is described, and the advantages of this method are outlined. For larger quantities of fresh water, a conventional type of dist plant or a flash-type dist plant must be used. As an example of the latter type, the Aquaflash plant is described. G. D. F.

529. Let's go after the cause of piping vibration. J. P. Chamberlain. *Petrol. Engr*, Sept 1960, **32** (10), C30.—Pipeline vibrations are classified as free, forced, or self-excited. Various examples of pipeline vibrations and their effects are given, and methods are suggested for removing the vibrations. G. D. F.

530. Spain seeks bigger role in petroleum. E. Recasens. *Petrol. Engr*, Sept 1960, **32** (10), E2.—New Spanish petroleum laws (Dec 1958) are renewed and discussed, and lists are given of exploration permits already granted in Spain, Spanish Guinea, and Spanish Sahara. There is a brief geological survey of these regions. Some 70 wells drilled so far in Spain are listed. The remainder of the paper deals with refineries in Spain and her overseas territories, petrochemicals, distribution facilities, and gives some information on the markets. G. D. F.

531. £60 million spent on Nigerian oil search. Anon. *Petroleum, Lond.*, 1960, **23,** 418.—Present Nigerian oil production is *ca* 1 million tons/pa. Most of the production is from the E Region, with small finds in the W Region. Present exploration is outlined; work on the new tanker terminus at Bonny Island is also mentioned. G. D. F.

532. Bright spot in the Far East—the Philippine Islands. B. M. Gozon. *Petrol. Engr*, Oct 1960, **32** (11), E2.—The Petroleum Act of 1949, governing concessions in the Philippine Islands, is summarized. There is a map and list showing the concessions at present taken up, together with other information. There is a brief description of the geology of the country. Exploration and drilling activities are listed. Refineries (one complete, three planned or under construction) are described briefly. G. D. F.

533. Refining trends over 21 years. G. A. Dickins and D. H. Tullis. *Petroleum, Lond.*, 1960, **23,** 377.—The pattern of consumption of petroleum products in the U.S.A. and Europe are contrasted—in the former, gasoline is the most important product, while diesel and fuel oils are most important in Europe. Refining trends in Europe have also been governed by the Middle East crudes available. Various process developments over this period are mentioned, such as cat cracking, hydrogen treating, etc. Probable future trends are discussed. G. D. F.

534. Past and future—the economic impact of oil. T. H. H. Skeet. *Petroleum, Lond.*, 1960, **23,** 373.—The growth of refinery capacity in the U.K. since 1938 is shown, and the rise of the British petrochemical industry is outlined. The important developments in petrochemicals in W Germany and Italy are mentioned. The relationship between coal and oil and the problem of future oil supplies are discussed briefly. The growing Soviet petroleum potential is seen as a possible future threat. Finally, the tanker situation is reviewed. G. D. F.

535. Greater worldwide acceptance comes to French petroleum equipment. G. Henry. *Internat. Oilman*, 1960, **14,** 217–18.—A large increase in French manufacture of most kinds of petroleum equipment is reported. Except for a few special items, production is sufficient to meet all French needs. Tubular goods and refinery equipment up to complete installations are exported. G. B.

536. Applied hydrocarbon thermodynamics. Pt 19. W. C. Edmister. *Petrol. Refin.*, July 1960, **39** (7), 133–42.—Correlations have been obtained for liq and vapour phase fugacity coeff of hydrocarbon mixture components. They are given as functions of the reduced temp, reduced pressure, and the bp ratio. The work was based on data of fugacity values determined by Benedict *et al* for 12 light hydrocarbons at pressures up to 3600 psia. M. J. M.

BOOK REVIEWS

Marcus Samuel. Robert Henriques. London: Barrie and Rockliff, 1959. Pp. xi + 676. 42*s*.

An astounding and romantic story is narrated in this splendid biography of Marcus Samuel. The author is an experienced writer who has not hesitated to describe with unusual candour both the strength and weakness of a remarkable man. Deprived by nature of many of those physical and social attributes that attach to successful men in commerce and politics, Marcus was, nevertheless, able by sheer force of character to acquire both wealth and social standing, whilst building an organization of world-wide importance and fame. The Samuel family business into which his lot fell operated as city merchants dealing with Eastern produce, of which sea shells formed a not inconsiderable part, and it was not until the firm became interested in marine oil carriage that Marcus scented a quicker way of making money. He became aware of what Alfred Suart and others had been able to achieve with tankers carrying oil in bulk, but he foresaw the additional advantage that would accrue from building better vessels that could carry Russian oil in bulk on outward-bound passages to the East and bring home his produce in cleaned tanks. He therefore sought the aid of a famous firm of naval architects, Fortescue Flannery, to design vessels that would serve the dual purpose and yet provide precautions that would secure authority for the transit of oil through the Suez Canal. In great secrecy vessels were built and transit permits obtained, and he was thereby enabled to compete with Standard Oil and undercut prices of kerosine in the Orient, after making highly favourable contracts with Rothschild interests for Russian oil at Batum. The success of this manœuvre alarmed and infuriated Standard Oil, who, by price cutting at the expense of lucrative home markets, had sought to drive them out of business. In the meantime Mark Abrahams, a young nephew with engineering training, had been despatched to the Orient with instructions secretly to acquire convenient sites at strategic points for the installation of storage tanks and port facilities under the guise of coal bunkering stations. This he

accomplished with astounding acumen and success, although under incessant criticism from London on the score of expense. Only one important matter was initially overlooked, namely, that of providing for the inland distribution of oil in tins, for which latter the demand was greater than for the contents. This omission was soon remedied by the hasty despatch of tin-making machinery to all centres.

The success of these schemes and the fortunate advent of the Russo-Japanese war in 1895 not only gave Marcus his first wealth but also enabled him to obtain unlimited credit for pursuing other ambitious projects in mind for fighting the aggressive tactics of the Standard Oil Co. A heaven-sent opportunity occurred when a Dutchman with oil concessions in Eastern Borneo approached Marcus after the Royal Dutch Petroleum Co had declined to negotiate a deal. Regardless of caution urged by his partners, Sam Samuels and Neville Benjamin, he impulsively entered the oil production business after only the most casual investigations by Mark Abrahams and several others. Enthused by the wealth of oil seepages, Mark courageously proceeded amidst his other onerous duties to prepare for drilling in pestilential, unfrequented jungle.

Many pages are devoted to an account of the attempts of Mark to deal with the ignorance and drunkenness of a sickly staff, and his endeavour to overcome drilling and other difficulties with incomplete and unsatisfactory equipment sent out. Mark's sole acquaintance with oil production was obtained during a three weeks' visit to the Baku oil-fields in 1896. For his services in carrying out these herculean tasks he was rewarded by a salary of £5 per week, raised later by his parsimonious employers to £5 10*s*. per week.

Although many years were to elapse before the difficulties of producing and processing an oil differing markedly in properties from those of Russia, the U.S.A., and Sumatra, the operations served the worthwhile purpose of frightening the Royal Dutch into partial compliance at times with the main objective of Marcus for a fusion of interests in which he would be master. The progress and recession of these overtures fluctuated for years with the alternate fortunes of the two companies occasioned by such factors as a varying Royal Dutch production, the need for transport and distribution services, and the behaviour of the Standard Oil Co. From early youth Marcus was impelled with a fanatical desire for wealth and position, and when profits appeared to warrant an approach to his dream in 1897 he purchased the Mote and contents with extensive grounds near Maidstone, where he lavishly entertained. He also bought a town mansion in Portland Place, whilst seeking to advance his social station through civic duties. His conspicuous talents were soon recognized by the City Corporation by nomination first as an Alderman in 1891, later Sheriff, and finally Lord Mayor at a time when his fortunes were insecure and he was beset by many difficulties, left to his anxious partners to surmount.

Marcus delighted in the pomp and pageantry of the Mansion House functions and enjoyed his morning rides in Rotten Row alongside London élite; but with opulence came corpulence and a tendency towards arrogance, pomposity, and self-importance that concealed better qualities. He had perforce to leave his business dealings to his two loyal partners, Samuel Samuels and Neville Benjamin, who almost unaided, except for the help of Fred Lane, ran this great organization as a one-man show. Marcus quarrelled with almost everyone and his irrepressible optimism worried his partners, who endeavoured to moderate his impulsive enthusiasm. Nevertheless, he was faithfully served by his loyal colleagues, although eventually even Fred Lane, who handled all the shipping and brokerage affairs, was driven in despair to resign his directorate of Shell. In doing so he gave his reasons in a masterpiece of phrasecology exposing the many objectionable weaknesses of a self-satisfied tyrant.

A curious yet praiseworthy trait was his passionate patriotism and support of all things British, strikingly exemplified when he contemptuously declined a cash offer of £2,000,000 for his Shell shares by Standard Oil, desirous of removing a hindrance to their world-wide plans. In the perusal of the book one is led at times to admire and sympathize with Marcus in his troubles, and at other times one is irritated and annoyed by his irresponsible conduct. At some of the early Shell meetings he had a very unfriendly reception when anticipated profits had not been realized, for shareholders could not be expected to understand the many causes that influenced earnings when attacked by unscrupulous opponents. Certainly Marcus ran very grave risks at times, but always something unexpected turned up and saved him from disaster at critical junctures.

His conviction that fuel oil was destined to replace coal as a medium of power generation led Marcus to strain every effort to induce the Admiralty to carry out proper tests, but for years he fought a losing battle against hostility, although warmly supported by Admiral Fisher, who became his lifelong friend. Notwithstanding these repulses, he never relaxed his efforts to ensure supplies of fuel oil, and he was the first to appreciate the enormous significance of the Spindle Top gushers of Texas in 1901, and at once proceeded to make big long-term contracts with the Mellons, who controlled the Guffey interests on the Dome. Although circumstances prevented the fulfilment of his contract, the deal led to amicable and sensible arrangements which assured valuable friendships.

The eventual appointment of Deterding to the presidency of the Royal Dutch Co led to a modified relationship between the two concerns, for both recognized the benefits that would accrue from a fusion of interests, although each was equally determined to hold the whip hand. Incessant quarrels never marred a friendly relationship, each appreciating the good qualities of the other; but Deterding's strength lay in his determination to be surrounded by first class technologists and clerical assistants, whereas Marcus, prejudiced by unfortunate past experience, had no faith in geologists and chemists, and left the office to be run by a handful of unqualified men. Due to his parsimonious attitude the Royal Dutch were able to acquire valuable concessions in Borneo discarded by Marcus through ignorance of their worth.

Not until 1901, when Mark Abrahams was recalled to London after a favourable report on his Oriental work had been made by Sam Samuels, was recognition of his valuable services made by a payment of £5000. This enabled him to marry before he was despatched to the U.S.A. to purchase oil-producing properties in pursuance of Marcus' intentions to fight the Standard Co in their own privileged markets. Only in this way did he consider that he would be left unmolested in the East. Marcus engaged for the first time a university graduate, Waley Cohen, with scientific training, who was destined in future years to play a major role in Shell group happenings.

In 1906 Marcus was virtually compelled by a succession of unfortunate trading experiences to accede to Deterding's terms on a 60/40 per cent basis, thereby giving to the Dutch oil seniority in an organization in which he had determined to keep control. He never forgave the British Government for withholding their support to a company with enormous potentialities when approached, and even worse, imposing obstacles in his efforts to expand. Although taunted with Jewish and selfish motives by an unfriendly Press and subjected to official ostracism by going so far as to give priority to other nationals in acceptance of tenders for oil, he never

lost his faith in British justice and institutions. He frequently betrayed his bitterness in speeches, but when war broke out in 1914 he displayed his fanatical patriotism by magnanimously and unreservedly placing the Shell resources at the disposal of the government.

The many advantages of the Shell–Dutch combine were quickly manifested by the formation of subsidiaries with qualified staffs to deal with varied aspects of their business. The Anglo-Saxon Petroleum Co was entrusted with the transport and storage of oils, and the Asiatic Petroleum Co was formed to handle the marketing of products. As chairman of Shell and both subsidiaries Marcus was still in a position to expound his ideas, which, if not always commending acceptance, proved the vitality of his mind. In fact, many of the schemes he had so ardently pressed on the authorities saved the country from disaster, such as the use of oil fuel for the Navy and the bulk storage of fuel oil in underground stores for just such an emergency as war. Through his persistent advocacy, despite official opposition, for the carriage of fuel oil in the double bottom of vessels, over 1,000,000 tons of much-needed oil reached England safely during the war period. Of equal or even greater importance was the extraction and delivery of toluol from Borneo benzine, an essential ingredient for the production of TNT. But in addition to its use as a steam generator, suitable oils were produced for air and ground services, for flame throwers, coast defences, and smoke screens, besides their use for calming seas during life-saving operations from damaged vessels. In order to hasten the production of TNT, Deterding, in collusion with the Dutch Government, agreed to the secret removal of a TNT factory from Rotterdam to England in 1915. By the end of the war 30,000 tons of TNT had been produced in plants run by Shell and Royal Dutch experts. To Marcus must also be given credit for the return to earth via exhausted oil wells of 400,000 tons of unwanted oil produced in Borneo which could be safely preserved until needed.

In 1918 the Shell Co capitalized £3,000,000 of reserve funds by a bonus issue, and on recommending payment of a 35 per cent tax free dividend mentioned that £11,000,000 was invested by the company. At one time during the war the Royal Dutch Shell Co had invested £20,000,000 in war loans. In 1918 Henry Deterding was awarded a knighthood in recognition of his valuable services. At the 1919 Shell meeting Marcus announced another 35 per cent tax-free dividend on the increased capital, and for the first time Shell shares reached £10, thus fulfilling his prophecy made 20 years previously. He explained that the bulk of their profits were made outside the United Kingdom and not from home sales. His faith in the oil industry had been handsomely rewarded by his important acquisitions of oil property in the U.S.A., Venezuela, Mexico, Trinidad, Rumania, and his share in Iraq. Starting with the Roxana Co under the direction of Mark Abrahams, the Shell and Royal Dutch combine expanded its operations until it became one of the leading oil companies in the U.S.A.

Only on the termination of the 1914–18 war were the great services of Marcus Samuel recognized and publicized in Parliament and in the Press and in 1921 his name appeared in the birthday honours list with a bestowal of a peerage. Under the title he assumed of Lord Bearsted he lived a rather retired life with failing health, and he did not long survive his elevation to the Viscountcy in 1925. He died at his home, 3 Hamilton Place, within a few days of that of his devoted wife Fanny, and they were buried together. A few months earlier, the death of Fred Lane was announced; he was one of the few great oilmen whom no one could charge with unethical conduct, although constantly embroiled in delicate brokerage deals in which Marcus was an interested party.

Henriques' great work can be recommended to all engaged in the oil industry as a record of early manœuvres of major oil interests to secure seniority in the sale of a competitive and essential product of modern life. A. B.T.

Analytical Chemistry—Some New Techniques. A. G. Jones. London: Butterworths Scientific Publications, 1959. Pp. vi + 268. 40*s*.

This book has been written for the purpose of presenting to the non-specialist senior analyst an introduction to a number of the newer analytical techniques which have had increasing application in recent years. The subjects with which the author has dealt have been those of particular interest to himself and ones on which, judging from his treatment of them, he has undoubtedly had practical experience. They are flame photometry, differential spectrophotometry, gas chromatography, the use of ion exchangers in analytical chemistry, acid–base titrations in non-aqueous media, coulometric titrations, differential refractometry, and the determination of oxygen and hydrogen in metals.

In considering each of the techniques, the author reviews the progress made during the period 1950–57, presents clearly in simple terms the principles involved, discusses in some detail the equipment employed, and gives sufficient practical examples to provide the reader with an appreciation of the scope of application of the technique.

The book is well illustrated with good quality diagrams, and the references are adequate and very well selected.

H. P.

Introduction to Practical Infra-Red Spectroscopy. A. D. Cross. London: Butterworths Scientific Publications, 1960. Pp. vii + 80. 17*s*. 6*d*.

In writing this short manual the author had in mind primarily the organic chemist, who has come to rely more and more on the assistance of infra-red spectrometry in the elucidation of molecular structure.

The first half deals with the simple theory and practical aspects of infra-red spectroscopy, including the design and operation of the spectrometer itself, cell construction and sample preparation, and other considerations necessary for the production of suitable spectra. Other chapters deal with intensity measurements, hydrogen bonding, and the interpretation of spectra.

The second part is composed mainly of well-presented correlation charts and tables of group absorption frequencies. The references, although far from comprehensive, have been carefully selected.

The author has provided in concise form sufficient information for an understanding of what is involved in the production and interpretation of spectra, although it is felt that the interpretation aspect could have been dealt with more fully.

The chemist unfamiliar with infra-red spectroscopy will undoubtedly find this publication useful, and so too will the undergraduate who has this subject included in his course of study. H. P.

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OILFIELD EXPLORATION AND EXPLOITATION

GEOLOGY

537. Diagnostics of petroleum's origin. (In German.) K-Krejci-Graf. *Erdöl u. Kohle*, 1959, **12**, 706–12, 805–15.—Pt I. Origin of the mother substance of petroleum. Organic substance transformation. Pt II. Pointers for petroleum's origin. Abstract and conclusion.—Coals and oil shales show that under various deposition conditions different org mol are preserved or formed. Time up to final embedding with O_2 shut off is decisive for the final product. A burned forest never turns to coal, decaying org substance never turns to petroleum. According to the intensity of disturbances—selective if they do not affect the whole mass—only the most stable and labile materials remain and undergo further transformations, the end product varying with material type. It appears that only coals originate from peats, only oil shales from gyttia, and solid and liq bitumen only from sapropelites. Just as different Kaustobioliths are formed under different deposit conditions, the petroleums must show characteristic differences if they originate in different media. Porphyrin and metal bearing are attached to heavy mol, therefore are exposed with these to selective multiplication and diminution in the migration. Up to now only ozokerites appear to permit geotechnical separation, general differences are not found with petroleums and asphalts. However, enrichments of the coals (deuteroatioporphyrin, Ge, Be, As, and gyttia (V : Cr)) are not found in petroleum. Enrichment of the light C-isotopes points to a closed circulation, also stagnating H_2O. This indicates petroleum binding to a definite facies, the sapropels. Pt II. The micronaphtha theory, a valuable new argument for petroleum's biogenic origin, needs modification to include facial signs of bitumen formation; in the first place metal traces and hydrocarbon-isotopes of the micronaphtha might be investigated. Clearly all the hydrocarbons present do not concentrate everywhere to deposits, *e.g.* in coals in which solely paraffin hades are known, and tar drops, products of fires. Supposedly, bitumen formation, also phenomena in liq migration undergo development. It can be assumed that—from a mother rock—the most mobile liq migrate first, followed by the viscous liq. As long as bacterial activity continues, light liq and gases are formed. However, it might be supposed also that—after consumption of the

energy-rich mol—the disproportioning always becomes more intensive, finally leading only more to solid bitumen, until finally conversion ceases completely. Presumably, many classes of cpds transform at pressure–temp conditions attained later. Deposit pressure increases in different regions, but always quicker than hydrostatic pressure with depth. Liq rising in a fissure has an excess pressure and can penetrate the pores in the reservoir rock. First, mother rocks, then reservoir rocks may be filled and pressures maintained which do not permit further diffusion. Later migrations then rise higher. Besides the disparity of the physical–chem properties of the various mixtures formed at different times, changes in retrograde condensation, filtering, etc., play a role; phenomena which generally work together, of which, however, one or the other can be so dominant that it assumes control. In any case justice is not done to the procedures with simple models. 167 refs. R. T.

533. Nomenclature of sedimentary rocks. (In German.) H. Füchtbauer. *Erdöl u. Kohle*, 1959, **12**, 605–13.—Grain size gradation is combined with the known petrographic fundamental diagram, whereby the latter is extended to sand types, quartz, sandstone, arkose, greywacke, and carbonate rock types. This seems necessary in view of the very complicated mixed rocks in the tertiary molass of S Germany. In working out the nomenclature the following scheme was determinative. The nomenclature is descriptive, not genetic. No new nomenclature is developed. Solely, usual notations are arranged in a more sharply defined scheme. Rock terms may be modified according to type of investigation. Freedom in expressing impurities is permissible, but general rules are presented. Explanatory tables and triangular diagrams are presented. 57 refs. R. T.

539. North Louisiana drillers find luck in Tensas parish. F. J. Gardner. *Oil Gas J.*, 9.1.61, **59** (2), 117.—A recent discovery in Tensas parish, Louisiana, in an area of old dry wells, has stimulated drilling in the area. The test, 1 Tensas Burial and Benefit, flowed 184 bd from Cretaceous Lower Tuscaloosa at 9129–9139 ft. 5 miles to the NW at the Buckhorn field a new pay has been found which is pre-Tuscaloosa in age. Stratigraphic traps are present in the area. C. A. F.

540. Take another look at the surface for clues to stratigraphic traps. J. B. Shrewsbury. *Oil Gas J.*, 9.1.61, **59** (2), 118.—There are many possibilities for stratigraphic trapping in the Illinois Basin, where there are considerable variations in formations, particularly in the Mississippian Chester series. It has been found that directional properties of thick, well-developed sandstones observed at outcrop correlate best with trends mapped basinwards. It is suggested that subsurface trends and thicknesses could be predicted from outcrop studies, not only for Illinois, but also in similar basins elsewhere, provided tests showed this to be reliable. In Illinois the method is especially suitable because of potential pays down to a total depth of *ca* 1300 ft. C. A. F.

541. Abo reef play yielding large oilfields. W. J. LeMay. *World Oil*, Dec 1960, **151** (7), 91.—The geology and morphology of the Abo reef in SE New Mexico are described. It is a transgressive barrier reef separating the lagoonal deposits on the NW Shelf from clastic deposits in the Delaware Basin during the Permian Leonard. Three distinctive lithologies are found in the reefing: (1) basin deposits (Bone Spring); (2) reef; and (3) shelf (Abo). The reef was found productive in 1951 and was topped at *ca* 8000 ft. Pays of over 600 ft thick have been found. Since Dec 1959 there have been four separate reef finds in the area, and there are now six reef fields under development in the Abo. Details of the stratigraphy are given: there are no fossil remains in the reef, which is a clean, white to pale tan and grey anhydritic dolomite. Original fossil assemblages have been destroyed by dolomitization and recrystallization. Anhydrite inclusions occupy many fractures and vugs, mainly near the base of the reef. Secondary porosity is well-developed, and is related to vertical fractures providing channels for solution and dolomitization. Vugs were created at intersections of fractures, and the existing porosity, which is irregular, is partly fracture and partly vugular. In places communication is poor, gas being locally trapped in some low structural areas where low porosity and permeability can be attributed to excessive anhydrite deposition.

Recoverable reserves are estimated at over 65 million brl, and further fields of similar size are expected to be discovered soon in the general area. Six refs. C. A. F.

542. Management thinking changes in California. Anon. *Oil Gas J.*, 26.12.60, **58** (52), 197.—Before 1950 most exploration for gas in the Sacramento Valley in California was concerned with locating closed anticlines, but in recent years deeper stratigraphic traps have been sought, following the development of sand stringer pays in the River Island field. Several new gas fields have been found, including Beehive Bend Willows, Perkins Lake, and Comptons Landing. Pays are sands, mainly from 2000 to 7000 ft, the most prolific to date being at Beehive Bend Willows below 6000 ft. Other stratigraphic finds are being developed.

The geology of the Walnut Grove–River Island area, *ca* 20 miles S of Sacramento, is outlined. Pays are thin sands in the Eocene Nortonville and Capay in fault block closures. Production at Walnut Grove is on the W plunging nose of the Thornton gas field. Gas has accumulated structurally against the fault in each block, and many stratigraphic pays are found on the flanks. C. A. F.

DRILLING

543. Engineering practices manual. Pt 3. Care and maintenance of tool joints. S. G. Marshall and C. R. Frederick. *World Oil*, Dec 1960, **151** (7), 109.—Methods for treatment and repair of tool joints are described with close-up photographs of damaged equipment showing repair jobs. Serious damage should be treated in a qualified machine shop, but most repair jobs due to handling can be carried out on the rig with hand files, provided the damage is detected early. Crews should be properly instructed in the use of shoulder dressing tools and, in programming bit weights and drill collar string required, the buoyancy factor of the mud should be considered. A chart shows buoyancy factor for various mud weights, and an example of its use is given. C. A. F.

544. Bottom-hole ball magazine allows breaking down formation selectively. C. B. Holt and D. E. Holt. *Petrol. Engr*, Dec 1960, **32** (13), B32.—A brief paper describes with the aid of diagrams a bottom-hole ball magazine which it is claimed enables perforated formations to be broken down a few holes at a time, thereby ensuring treatment even in regions of low permeability. Balls from the magazine seal off completed perforations and are removed on completing the treatment. Tests are described. G. D. F.

545. New pipe configuration reduces wall sticking. F. K. Fox. *World Oil*, Dec 1960, **151** (7), 83.—Wall-stuck pipe has been a continual problem in drilling, particularly when a high-solids drilling fluid is used, and there is a large pressure difference between the hydrostatic pressure of the mud column and the formation pressure in a permeable section. Under these conditions pipe can become stuck after a few sec rest. Cases of stuck pipe are analysed in detail, and the problem has been investigated in the lab. Although centralizers and scratchers reduce sticking of casing, they need to be closely spaced to reduce the contact area of the casing and hole wall. A new

method is proposed in which differential pressure sticking is reduced by modifying the basic design of the drilling string. A modified drill collar is used in which several grooves are spiralled down its length; this retards balling up of the collar but reduces stability. The total sticking force due to differential pressure is effectively reduced in this way, and during the past year over 100 deep, high mud weight wells have been drilled using these collars. C. A. F.

546. Logging programme for the Paradox Basin. G. F. Chamberliss. *World Oil*, Dec 1960, **151** (7), 104.—Most wells drilled in the Paradox Basin in the Rocky Mountain area are aimed for the Pennsylvanian Hermosa group, but recent wells suggest that the Mississippian and Devonian may be future important objectives. Logging programmes must therefore be planned to serve several potential pay formations. Pennsylvanian pays usually have water with NaCl ranging from 50,000 to 200,000 ppm with R_w ranging from 0·08 ohm-m to 0·028 ohm-m. Muds are usually fresh (gel) with NaCl 5000–10,000 ppm. Pays are mainly limestones or dolomites.

Mississippian and Devonian pays carry waters ranging up to 200,000 ppm NaCl. Muds are usually salt saturated. Mixed lithologies produce, and two porosity tools should be run. Recommended programmes are tabulated. C. A. F.

547. Mechanical aspects of rig moving. M. T. Parker. *Drilling*, Nov 1960, **22** (1), 64.—Many rigs are moved almost weekly, and moving costs may run to 20% of total drilling costs. Future rigs need to be designed to be moved and re-assembled in a few hours. Time taken in aligning components can be reduced by good initial site-levelling, and by the use of locating stops and dowels. Air hoists can be useful for moving many small items before the main engines are usable. Electric drives simplify moving, as prime movers are set on the ground; there is no limitation on substructure height, and there are few alignment problems. In remote areas high load capacity trucks are used to move large rig units, using large wheels with LP tyres, furnished with individual electric drives, and further development of this scheme is possible. J. C. M. T.

548. Practical ways to find proper bit weight and rotary speed. II. E. M. Galle and H. B. Woods. *Oil Gas J.*, 21.11.60, **58** (47), 160–6.—Charts and tables are provided for determining optimum bit wt and rotary speed for different field conditions, based on the relations discussed in Pt I. For each formation the following information must be available from a run at constant speed and wt. Bit size and type, rig cost/hr, bit cost, trip time/1000 ft, depth, footage, rotating time, wt, rotary speed, dullness of bit, and bearing conditions. Sample problems illustrating the method are given. J. C. M. T.

549. Centrifugal mud pumps are big money savers for Gulf Coast drillers. F. Manning. *Oil Gas J.*, 5.12.60, **58** (49), 106–8.—Centrifugal pumps can be used to operate mud hoppers, agitate tanks, supercharge the main pumps, operate degassers and desanders. They are cheaper, smaller, lighter, and use less power than reciprocating pumps, and can be skid-mounted direct coupled to high-speed engines. Suction lines should be short and sharp bends avoided. J. C. M. T.

550. Laboratory evaluations and field testing of silica CMHEC–cement mixtures. C. F. Rust and W. D. Wood. *J. Petrol. Tech.*, Nov 1960, **12** (11), 25–9.—Lab tests show oil-well cements of all types to have a drop in compressive strengths above 250° F, giving dangerously low values at *ca* 300° F; the permeability increased at the high temp. Addition of suitable amounts of silica counteracted these effects. CMHEC controls the water loss and retards thickening time.

Tests were made mainly at 15·2 lb/gal with 0–1% CMHEC and 0–50% silica. Thickening times, filter loss, and compressive strength were examined. In six field tests placement of cement was at 12,590–14,490 ft (280°–320° F), using 0·35% CMHEC and 30% sand. The casing with scratchers and centralizers was reciprocated. The percentage fill (over as much as 5000 ft) was considerably better than for neat cement slurries. Drill stem tests showed no signs of loss of isolation. The cements cost 25–35% more than neat Class E cement. G. D. H.

551. Reaction and properties of silica–Portland cement mixtures cured at elevated temperatures. F. D. Patchen. *J. Petrol. Tech.*, Nov 1960, **12** (11), AIMME Tech. Paper No. 8134, 281–7.—The properties of Portland cement–fine-ground silica mixtures have been studied, the set cement having been cured for periods up to 60 days at temp of 180°–350° F. Suitable amounts of silica give superior properties above 230° F. The early compressive strengths were higher and increased on further curing, thickening times increased, and permeabilities were markedly lower. 35–60% of silica gave good results.

X-ray studies of the hydrated cements showed dicalcium silicate α-hydrate in all the neat cements cured above 260° F, and a max amount of this was produced by 10% by wt of added silica. 39% of added silica was computed to be necessary to form a monocalcium silicate which gives high strength and low permeability. Tobermorite and xonotile have been identified as the high-strength hydration products of cements cured above 320° F and containing over 35% silica by wt. The silica is not a filler up to this proportion; it should be under 100-mesh for satisfactory reaction. G. D. H.

552. Acoustic log checks casing cement jobs. C. H. Thurber and B. F. Latson. *Petrol. Engr*, Dec 1960, **32** (13), B84.—The possibility is shown of using an acoustic logging method for checking on the whereabouts and quality of casing cement jobs. The method of interpreting the logs is discussed. G. D. F.

553. Electrical equipment for offshore drilling stations. (In German.) G. Loy. *Erdöl u. Kohle*, 1959, **12**, 641–6.—Equipment of mobile drilling installations is dealt with, also from a floating ship, developed in the U.S.A. for drilling at great depths. The article is limited to drilling in the Persian Gulf and off Trinidad. Details are presented—with equipment illustrations—of operations and safety measures adopted. R. T.

PRODUCTION

554. Volumes of liquid hydrocarbons at high temperatures and pressures. G. H. Alani and H. T. Kennedy. *J. Petrol. Tech.*, Nov 1960, **12** (11), AIMME Tech. Paper No. 8135, 272A (summary).—An equation was derived for the molal vol of pure hydrocarbons over a wide range of pressure and temp, and adapted to apply to mixtures, the heavy hydrocarbons being expressed as C_{7+}.

$$RT = \left(P + \frac{a}{v^2}\right)(V - b)$$ where V is molal vol $a = Ke^n/T$

and $b = mT + C$, K, n, m, and C being constants for each hydrocarbon. For mixtures $a_m = \sum a_i x_i$ and $b_m = \sum b_i x_i$, x_i being the mol fraction of each hydrocarbon, from methane to heptanes—plus. For the heptanes—plus a and b depend on the mol wt and density:

$$\log_e a_{c7+} = 3{\cdot}8405985 \times 10^{-3}M - 9{\cdot}5638281 \times 10^{-4}M/d + 2{\cdot}6180818 \times 10^{3}/T + 7{\cdot}3104464 \times 10^{-6}M^2 + 10{\cdot}753517$$

$$b_{c7+} = 3{\cdot}499274 \times 10^{-3}M - 7{\cdot}2725403d + 2{\cdot}232395 \times 10^{-4}T - 1{\cdot}6322572 \times 10^{-3}M/d + 6{\cdot}2256545.$$

The basic equation is cubic, and when there are three real roots the lowest is the required liq vol.

The relationships have been tested against 647 measure-

ments on 47 bottom-hole samples at 72°–250° F, and from bubble points to 5000 psig. G. D. H.

555. Improved method for calculating water influx. R. D. Carter and G. W. Tracy. *J. Petrol. Tech.*, Dec 1960, **12** (12), 58–60.—By means of the convolution integral, cumulative water influx is expressed as a function of varying field perimeter pressure, and water influx is approximated by a series of constant rate intervals. It can be shown that the resultant equation using a fictitious influx history is an approximation to van Everdingen and Hurst's superposition equation, and it improves as the time intervals used in both cases are lengthened. Above the bubble point an equation is given for the explicit step-wise calculation of pressure history for a prescribed oil production history. The new approach avoids the labour involved in superposition calculations.

Examples are given comparing the calculations and predictions made by the different techniques. G. D. H.

556. Oilfield interference in aquifers of non-uniform properties. M. Mortada. *J. Petrol. Tech.*, Dec 1960, **12** (12), 55–7.—The case studied is one where the aquifer zone concentric with one oilfield has given values for permeability, porosity, and effective permeability, whereas the second oilfield lies outside this zone in a region extending to infinity, with different fixed values for these three quantities, but with the same formation thickness. In the solution the pressure gradient at the boundary of the first field is assumed constant, and at the boundary of its permeability zone the pressure and flux are constant.

The behaviour of uniform and non-uniform aquifers is compared, and it is concluded that variations in aquifer properties must be considered in studying oilfield interference if reliable results are required. This is because relatively small values of dimensionless time are involved. Oil well interference analyses involve fairly large values of dimensionless time, because the value is inversely proportional to the area of the sink; this permits simplifications in oil well interference calculations. G. D. H.

557. Equilibrium ratios for reservoir studies. F. H. Brinkman and J. M. Sicking. *J. Petrol. Tech.*, Dec 1960, **12** (12), AIMME Tech. Paper No. 8129, 69 (summary).—The new method for obtaining K values substitutes measurements of gross fluid properties for detailed compositional analyses which involve costly and time-consuming lab procedures. Information can also be obtained on the changing physical properties of the heptanes-plus in the liq and vapour phases with pressure. *Ca* 1 hr on an IBM 650 calculator is needed to establish a K chart.

The method has been tested on a crude oil and three condensates, giving satisfactory results for the latter.

G. D. H.

558. Conduction–convection in underground combustion. H. R. Bailey and B. K. Larkin. *J. Petrol. Tech.*, Dec 1960, **12** (12), AIMME Tech. Paper No. 8140, 70 (summary).—Heat transfer by conduction and convection between the reservoir and injected gas is considered for linear and radial systems, the combustion zone moving as a plane or expanding cyl with constant fuel consumption per unit of reservoir vol traversed. Infinitely rapid heat transfer between gas and rock is assumed, making the temp identical for rock and flowing gas.

It is possible to estimate the injection rate needed to attain a given temp. Assuming a given temp for supporting combustion, air rate, fuel density, and injection composition can be established. G. D. H.

559. Study of the spontaneous displacement of one fluid by another in a porous medium (imbibition). (In French.) M. Lanchon. *Rev. Inst. franç. Pétrole*, 1960, **15**, 1294–346.—Consideration of certain simple geometrical forms approximating to pores and capillaries has drawn attention to fundamental features which may be involved in displacement. The height and dia of the test specimen, its porosity, permeability, pore morphology, and wettability are probably of importance. Fluid density, visc, and interfacial tension will be involved. The plan to use carefully graded loose sands held in mesh containers in order to investigate the influence of pore size on a material of constant composition failed. Solid samples had to be used, and these were finally placed in beakers, standing on pegs in a stirrup arrangement to permit weighing. Oil was expelled from the saturated cores when immersed in water. The expulsion was slow, and no clear relation was shown between the resultant curves and the height and dia of the samples. Some bacteria developed during the long tests. Formaldehyde controlled this; better bactericides suffer from being surface-active substances. Wettability of the surface affected the results.

Further experiments used samples treated so as to make them oil-wet or water-wet. The resultant curves showed more definite links with the dimensions. The taller the samples for a given dia, the higher the residual saturation. For water-wet samples the oil saturation is reduced comparatively rapidly; for oil-wet samples the reduction is slower; both had final saturations of *ca* 50% after 50 days. Pore heterogeneity favours displacement by surface forces.

G. D. H.

560. Foaming agents remove water from gas wells. R. G. Schmidt. *Petrol. Engr*, Dec 1960, **32** (13), B51.—A method is described for dewatering gas wells by the use of a 50% mixture of a detergent type foaming agent and alcohol, which is injected by means of a gas-pressure operated pump. The method is shown to be cheap and reliable. A typical case history of such a gas well is discussed. G. D. F.

561. Nitrogen can improve your production practices. R. A. Plummer and A. W. Smith. *World Oil*, Dec 1960, **151** (7), 96.—There has recently been a marked increase in the use of nitrogen in drilling and production, mainly for displacement in well completion, but also in perforating, fracturing, aerification of drilling mud, cementing, and testing surface equipment. Field jobs using nitrogen are listed. Liq nitrogen is transported to sites in large insulated vacuum type vessels, single units now providing gas vol of 175,000 scf at pressures up to 10,000 psi at well head. The unit assembly is mounted on a heavy duty truck. C. A. F.

562. How to reduce high tensile sucker rod joint failures. J. L. Walmsley and R. W. Helman. *World Oil*, Dec 1960, **151** (7), 105.—Tests on high tensile, ¾-inch sucker rods have shown that proper make-up torque is important in reducing rod failures. On test, rod joints were torqued to 150, 400, and 650 ft-lb, using standard API and slim hole couplings. Results were: (1) 150 ft-lb torque: 100% pin failure; (2) at 400 ft-lb torque, 1 million-cycle fatigue strength of joints is *ca* the same as that of rod body; (3) increasing torque from 400 to 650 ft-lb reduces pin failure from 36 to 13%; and (4) type of coupling (API standard or slim hole) has no effect on pin failure or fatigue strength on torque ranges used. Details of fatigue tests are given and results tabulated. Two refs.

C. A. F.

563. How to determine permeability from well log data. J. P. Johnson. *World Oil*, Dec 1960, **151** (7), 89.—Equations based on Archie's formula have been used for interpreting permeability from well log data. Logs used are those for salt mud systems and include: microlaterolog, velocity or neutron, and laterolog or guard. The principle of interpretation is based on the fact that the degree of flushing of the R_{xo} zones (and the ROS in the zone) is dependent largely on the permeability

of the reservoir rock, *i.e.* as permeability decreases the ROS increases in the R_{wo} zone. A plot of apparent ROS (%) against permeability is presented based on data from the San Andres formation in W Texas. The chart can be used only for zones of relatively low S_{wc}. Three examples are given.

C. A. F.

564. Efficiency of miscible displacement as a function of mobility ratio. B. Habermann. *J. Petrol. Tech.*, Nov 1960, **12** (11), AIMME Tech. Paper No. 8132, 246–72.—Models of 4½–15-inch side and ¼–½ inch thick representing one-quarter of a five-spot were made of sand cemented with epoxy resin and encased in transparent plastic to allow visual study of the displacement process. The permeabilities were 4·5–20 D. The mobility ratios were 0·04–100, the volumetric sweep at breakthrough being 78% for the former and 19% for the latter. Injection rates were 0·07–30 cc/min. At high mobility ratios extensive fingering develops, and this is the main control in displacement. Fingering promotes mixing, causing uneven distribution of the slug along the front. It appears that at high mobility ratios a miscible slug of 10% of the oil in place will deteriorate after only a small fraction of the reservoir has been swept, causing an enriched gas drive which approaches ordinary gas drive to replace miscible displacement as flow progresses. Only for mobility ratios below *ca* 2 will the slug remain as a band and give good microscopic sweep efficiency. High mobility ratios also give low areal sweep efficiencies.

G. D. H.

565. Approximation of gas-drive recovery and front movement in the Abqaiq field, Saudi Arabia. L. T. Stanley. *J. Petrol. Tech.*, Nov 1960, **12** (11), AIMME Tech. Paper No. 8133, 273–80. Abqaiq has a 200-ft carbonate reservoir *ca* 6500 ft deep, dips of 3°–10°, and 63 producible wells averaging *ca* 5000 ft spacing. The initial pressure was 3395 psig and the bubble point 2520 psig. Gas injection began in 1954 when the pressure was 2450 psig and the crestal free gas saturation *ca* 8%. Core tests indicated a critical gas saturation of 13%. In the S sector there has been an average injection rate of 122 MMcf/day. In 1957 peripheral water injection began in the N to keep pressures equal in the two parts.

Calculations have been made on the behaviour of the injected gas front, using three vertical zones in the reservoir. Performance shows the gas to be partially miscible with the oil, and the vol factor may vary appreciably, depending on the relative quantities of oil and gas in contact. The gas front advances most rapidly along the top of the formation, giving a flatter angle as advance increases. Drill stem test data and neutron log information on the gas/oil contact have been compared with the calculated frontal position of the gas.

A sample calculation is given.

G. D. H.

566. Discussion on "Effect of viscosity ratio on relative permeability." P. E. Baker. *J. Petrol. Tech.*, Nov 1960, **12** (11), 65–6.—Odeh put forward a hypothesis which was claimed to support a mechanism whereby relative permeability depends on the oil/water visc ratio and may exceed unity for high visc ratios. The existence of the vortices postulated by Odeh is doubted, and the validity of the mathematical treatment is questioned. There are difficulties in making measurements of relative permeability, and anomalous values may be a consequence of the method or the use of reactive cores. Interpretation of the experimental results quoted requires further information, and further experimental data seem necessary before the non-dependence of relative permeability on visc ratio is rejected.

G. D. H.

567. Controlled solubility phosphates—a versatile solution to oilfield scale problems. B. Sloat. *J. Petrol. Tech.*, Nov 1960, **12** (11), 30–6.—Scale may form by pressure reduction, change in temp, or change in the mineral characteristics due to the action of the water or to mixing waters. In the water flood cycle the water goes into a variety of environments calling for different equilibria. If the water can be retained for a sufficient time at some points, scale may be deposited where it does little harm. Phosphates have long been used to prevent scale formation by oilfield brines. Chemically, controlled solubility phosphates are fused Na–Ca, Na–Mg, or Na–Zn phosphates. The glassy phosphates are absorbed on the nuclei from which crystal growth would normally proceed, preventing precipitation at ion concn considerably above the solubility product. The solution rate of the phosphate depends on composition, particle size, temp, and nature of the brine. Glassy phosphate breaks down to inactive orthophosphate by reversion at high temp and low pH value. Commonly, under oilfield conditions, 50% reversion may require 1–2 weeks.

Two field case histories are given. One well was effectively treated for $48 for a year. In the other, phosphate was used to prevent the deposition of $BaSO_4$, which is acid-insoluble.

G. D. H.

568. Pin-point sand fracturing—a method of simultaneous injection into selected sands. W. B. Murphy and A. H. Juch. *J. Petrol. Tech.*, Nov 1960, **12** (11), 21–4.—Prior to fracturing the Eocene, the E side of Lake Maracaibo could not be exploited economically. The Eocene B-1 sand is 1000–3000 ft deep, made up of interbedded shales and fine- to medium-grained sandstones aggregating 50–1000 ft, 15–30% porosity, and 1–5 mD/cP mobility estimated before fracturing, becoming 15–40 mD/cP after sand fracturing. Early completions with pre-perforated liners on treatment probably had fractures in limited sections of the long interval. Selective treatment in stages was costly, as was the use of ball sealers. Immediate production increases averaged 700%.

A single ⅜-inch hole can take 1·3 brl/min of 2 lb/gal sand fluid at pressure differentials of 200–300 psi. For max injection rates of 25 brl/min 15–20 perforations can be fully treated, and so with multiple sands a sand might have only one perforation ("pin-point" method). Wells had 3–20 perforations, averaging one hole/5 ft of oil sand indicated by the microlog to have permeability. 1·5–2·6 lb sand/gal of fluid was used, the total sand being 25,000–100,000 lb.

79 wells with multiple perforations have been compared with 22 pin-point completions, all having at least one year's production history, by means of the producing rate/ft of oil-bearing permeable sand shown by micrologs. The pin-point completions were better than the others at corresponding levels in the first year, the advantage generally increasing with time. Pin-point completions averaged in cost $1700/well; conventional completions with four holes/ft would have averaged $5400/well.

G. D. H.

569. Effect of directional permeability on sweep efficiency and production capacity. B. L. Landrum and P. B. Crawford. *J. Petrol. Tech.*, Nov 1960, **12** (11), 67–71.—Differences between vertical and lateral permeabilities are well known; there are regions with differences in lateral permeability. At Bradford NE–SW permeability may be 25–30% higher than NW–SE permeability. In some limestone cores there were significant directional differences, the average permeability ratio being 16 : 1. Fluid-injection displacement performance in the Spraberry suggested a ratio of 144 : 1 between max and minimum. To avoid reduction of sweep efficiency, well spacing needs to allow for this condition.

Potentiometric studies were made. Variable lateral permeability has effects which depend on the orientation of the well pattern. There is a greater effect on sweep efficiency than on production capacity. If the wells are on a square pattern with N–S and E–W lines, with the E–W permeability three times that in a N–S direction, the sweep efficiency for a

five-spot pattern is *ca* 43%, for an E–W line drive 38%, and for a N–S line drive 79%.

Directional permeability may be obtained on oriented cores, by closing in wells around a producer during primary production, and observing the pressures. Analyses of pilot injection behaviour should take note of any fracture directions. G. D. H.

570. Electrically balanced well structures can relieve production problems. V. C. Crites and M. K. Fjeldsted. *Oil Gas J.*, 5.12.60, **58** (49), 96–102.—All oil wells have an electric potential, and in general the potential varies from well to well, so that when two or more are connected by flow lines electrolytic cells are set up. This leads to corrosion, and may also cause scale and wax deposition. These troubles can be combated by the use of magnesium electrodes strategically placed and connected to each well head via a resistor, their position being determined by an electrical survey. Seven case histories are quoted to show that treatment of this kind reduced wax deposition, scale formation, and corrosion. J. C. M. T.

571. What operators learned from competitive pumping tests. Anon. *Oil Gas J.*, 12.12.60, **58** (50), 105–9.—Pumping units in which the components have been rearranged to give a class III lever system have been compared in field performance with conventional units. The new design is claimed to give smoother operation with lower peak loads, and therefore less torque. Dynagraphs taken on the tests show that this claim is justified. Power consumption of the new design was 3·4% lower and production 3·2% higher than the conventional design, using the same speed, stroke, and down-hole equipment. J. C. M. T.

572. Recovery of oil by displacements with water–solvent mixtures. R. J. Blackwell *et al.* *J. Petrol. Tech.*, Nov 1960, **12** (11), AIMME Tech. Paper No. 8136, 272B (summary).—Channelling or viscous fingering of solvent through oil decreases sweep efficiency, and it has been suggested that a mixture of solvent and water would improve oil recovery. This combines the displacement efficiency of solvent and sweep efficiency of water. In lab models the light solvent usually flowed in the upper part of the sand ahead of the advancing water, which moved in a zone flushed partly or wholly by solvent. The effective mobility approached that of water, thereby increasing pattern efficiency. When the dip and permeability are sufficiently high the desired field rate may be less than the critical rate below which the gravitational force is effective in preventing channelling of solvent through oil. However, even when there is channelling and gravitational over-riding it is sometimes possible to get efficient displacement if the oil/solvent visc ratio is less than *ca* 10. The minimum amount of solvent for a given oil recovery increases with oil visc. It is believed that the water–solvent flood gives greater recoveries than solvent alone in practical vol. G. D. H.

573. Gas injection and LPG recovery in Kuwait. W. C. Renton and B. R. R. Butler. *Petroleum, Lond.*, 1961, **24**, 11.—It has been found necessary to carry out gas injection into the Wara sand of Kuwait's Burgan field. The systems for gas collection and compression are described, together with the utilities, auxiliaries, control system, etc. The second part of the paper deals with the bulk LPG project—the Kuwait Oil Co proposes to manufacture *ca* 200,000 tons pa of butane and propane. The LPG components will be extracted by the compression/cooling method. The plant for extraction and fractionation, and the storage and loading facilities, are described. G. D. F.

574. Secondary recovery by gas injection. J. Casanova. *Rev. Inst. franç. Pétrole*, 1960, **15**, 1261–93.—In most reservoirs natural producing mechanisms do not give more than 40% of the oil in place. Water-flooding or gas drive may be undertaken to increase recovery. Attempts may be made to reduce capillary effects by adding surface-active agents to water, or applying miscible drive with gas. The first intentional gas drive seems to have been air injection at Oil City in 1916; gas injection took place at Buena Vista Hills in 1924. In 1953 a tenth of U.S. production came from fields having gas injection. The first miscible drive was in 1949.

Injection to enlarge the gas cap has advantages over gas-cap expansion by pressure drop because pressure is maintained and there is better oil permeability. Gas drive on flat structures provides a sweep not available naturally, and is favoured by poor vertical permeability.

Air is less satisfactory than natural gas because of oxidn. N_2 may be used. Water vapour and corrosive cpds need to be removed. Selective plugging has been attempted in injection wells to reduce channelling. Alternate production and recompression has been suggested to drain tight sectors.

The efficacy of water sweeping is reduced by the breaking off of oil globules at pore necks. Consideration of systems of methane, light hydrocarbons, and crude oil shows that in addition to classical gas drive three forms of miscible displacement are possible by variation of the pressure or composition of the gas. For crudes rich in light components high pressure gas may give miscibility, and this has proved possible at 3000–4000 psi for a crude with 40% of light material. Gas enriched with propane and followed by dry gas has also been employed. A slug of propane and butane followed by a dry gas has been used, pressures over 1350 psi at 100° F being needed for methane–propane miscibility. Tests have indicated that the miscible slug should be some 10% of the vol of oil to be swept. Premature breakthrough must be avoided. High-pressure gas and enriched gas would automatically reform a miscible front. Water has been injected behind gas to reduce the troubles, the gas band being *ca* 5% of the pore space. The slug precludes the displacement of oil from tight sectors by the imbibition which can take place with water flood. Asphalts may be precipitated, clogging pores.

Starting with the fractional flow and frontal drive equations, the performance of reservoirs under gas injection can be examined, consideration being given to no vaporization of oil with complete or partial pressure maintenance for saturated oil, and to under-saturated oil, as well as to vaporization of oil. Attention has been paid to production after breakthrough. G. D. H.

575. World-wide oil. Anon. *Oil Gas J.*, 26.12.60, **58** (52). 97–152.—Data on reserves, wells producing and drilling, and production for 1960 are tabulated for countries and fields in Europe, Africa, W Hemisphere, Australasia, Asia, and the Middle East. Outstanding developments of the year in each country are noted. Total free world production was 17,628,670 bd, Russia and controlled areas 3,230,000 bd. J. C. M. T.

OILFIELD DEVELOPMENT

576. Field use of radioactive gas tracers. F. E. Armstrong. *Petrol. Engr*, Dec. 1960, **32** (13), B34.—It is shown that β-emitting isotopes can be used as radioactive gas tracers under field conditions. For the tests described here, krypton-85 was chosen as the tracer. The loss of this material was negligible under the test conditions. The tests involved addition of radioactive tracer to all the gas injected into a formation over a given period, in order to check on the directional permeability of the formation. The methods of injecting the tracer and detecting it in the samples are described in some detail. G. D. F.

577. Eight strikes lend glamour to Arkoma Basin's future. F. J. Gardner. *Oil Gas J.*, 2.1.61, **59** (1), 123.—The Arkoma

Basin lies athwart the Oklahoma–Arkansas border and contains several new gas fields, mainly in SE Oklahoma. 1 Brame in Pushmataha County, which was completed for 500 Mcf/day, was located in the Ouachita Mountains and the find has stimulated interest in the mountain region, thought by some to be an important future oil and gas province. Details of other Arkoma discoveries are given, and a map shows discoveries in the basin in 1960. Drilling in the area is difficult and geology complex. Pays are Pennsylvanian sands.

C. A. F.

578. "Noble gas" is new target for 1961. F. J. Gardner. *Oil Gas J.*, 26.12.60, **58** (52), 195.—The oil industry has shown an increasing interest in developing helium production. The richest known deposit in the U.S.A. is at Pinta dome, Apache County, Arizona, where it occurs as a minor constituent of natural gas. At Pinta helium concn is 8–9%, compared with *ca* 2% in the Panhandle fields. Rich deposits also occur at Harley dome, Grand County, and Woodside dome, Emery County, both with 7% helium. These fields have not been fully developed, mainly because the host gas is non-commercial; Pinta gas, for example, contains 90% nitrogen and is incombustible. Drilling is under way in the Pinta area and a new discovery 4 miles E of Pinta at Navajo is reported. Pinta gas occurs at 780–1200 ft in Permian and Trias sands, the Permian Coconino being the main reservoir. Reserve estimates range from 7½ billion cu ft gross recoverable, containing 0·6 billion cu ft of helium, to 22·5 billion cu ft gross gas and 1·8 cu ft net helium. C. A. F.

579. High drilling costs, varied geology fail to slow Arkoma Basin growth. R. N. Planalp. *Oil Gas J.*, 2.1.61, **59** (1), 124.—The Arkoma Basin in E Oklahoma and NW Arkansas comprises the McAlester and Arkansas Valley Basins, bordered to the N by the Ozark plateau and to the E and S by the Mississippian embayment and the Ouachita Mountains. Early gas development was in anticlines, and recently there has been deep development. Surface mapping and photogeology have been very useful in picking surface structures in Pennsylvanian sands and shales, but subsurface work has been limited by poor logs and sparse control. Shallow logging is at present often impractical because of drilling problems due to very hard shallow sands and many unpredictable water zones. Percussion drilling has been more successful than rotary in this area. Details of drilling and completion methods are described. Completion costs are often as much as or higher than for drilling, partly due to heaving shale in the Lower Atoka. In spite of these problems and the complex geology of the area, it is expected that there will be further growth in the development of the basin during the next few years, particularly if drilling problems can be overcome.

C. A. F.

580. Rocky Mountain four-basin report. Pt 1. J. A. Kornfeld. *World Oil*, Dec 1960, **151** (7), 99.—35% of all wildcats in the Rocky Mountain region are being drilled in Wyoming where production records have been set. Production comes from pays ranging from Cambrian (Lost Soldier dome) to Upper Tertiary. Present emphasis is on stratigraphic exploration, and main exploratory drilling is in the Green River, Wind River, Big Horn, and Powder River Basins, the Upper Cretaceous and Tertiary being the chief objectives. Exploration and development in each of these four basins are described. Powder River yields *ca* one-half of the state's cumulative oil production, and two major fields are the old established Lance Creek and Salt Creek fields. Recent operations in these are outlined with new developments at Rozet and Dead Horse Creek. There is active drilling in the centre of the Green River Basin, where Cretaceous fields, particularly Mesaverde, are being developed; important areas are Patrick Draw, Mickelson Creek, Big Piney, and Grizzly Buttes Unit. Well logging procedures are outlined. C. A. F.

TRANSPORT AND STORAGE

581. 1960 saw some real advances in pipe laying. P. Reed. *Oil Gas J.*, 2.1.61, **59** (1), 74–6.—The two most impressive measures adopted for cost reduction in pipeline construction during 1960 were a two-pipe-gang method for small dia pipe and double-jointing for large dia pipe. These are briefly discussed, and some details of other practices, including the use of air clamps and disk grinders, are given. A. D. S.

582. Flexible submarine gas pipeline. Anon. *Petrol. Times*, 27.1.61, **65**, 103.—The Magna pipeline project, for transporting 50 million cu ft of natural gas a day from British Columbia to Vancouver Island, will employ plastic pipes having an external dia of 7·5 inches and an internal dia of 4·85 inches. The pipe is designed to operate at a gas pressure of 1500 psi and will be manufactured in 4-mile lengths by BICC. It will consist of an extruded high impact pvc liner, with three layers of cotton bedding between which is a steel tape reinforcement followed by an extended lead alloy sheath. Four layers of steel tape reinforcement are followed by four layers of anti-corrosion serving. Next a jute bedding is wrapped round the pipe prior to the application of an armour sheath made up of galvanized steel wires. The pipe is finished off with three layers of bitumenized serving. A. D. S.

583. Thin-wall pipe for oil and gas lines. W. P. Heinemann. *Pipe Line News*, Dec 1960, **32**, 41.—Recent interest in thin-wall pipe (wall thickness of $\frac{3}{16}$ inch or less) has been motivated primarily by economics. It is standard design practice to operate large-dia gas pipelines at stress levels up to 72% of the minimum yield strength. External coatings and application methods have improved to a great extent recently, and good protection adds significantly to the pipeline's life. Internal corrosion is a serious problem, and the engineer should exercise caution in the selection of wall thickness. A useful graph presented in the paper shows wall thickness required, against nominal pipe size and stress levels to operate at 1000 psi (for AP15LX, 52 steel). Design pressure data for three different wall thicknesses, *i.e.* 0·188 inch, 0·156 inch, and 0·125 inch, are also included in the paper. M. F. M.

584. Submarine pipeline construction methods. 1. J. G. Bomba. *Petrol. Engr*, Dec 1960, **32** (13), D28.—The following basic problems are common to the design, construction, and operation of submarine pipelines: economics, hydrologic effects, meteorologic effects, bottom conditions, marine traffic, and the properties of the pipeline itself. The design of a sludge outfall line led to the development of the Friction Transposition method for pulling pipelines along the bottom with a minimum of damage. Other applications of this method are described. The design of a pipeline under the Mississippi is also described. G. D. F.

585. On the unsteady motion of compressible fluids in long pipelines. (In Russian.) L. A. Movsesyan. *Inzhenerno-Fizicheskii thur*, 1961, **4**, 22.—A mathematical treatment is given of the problem of unsteady flow of a compressible gas in a long main, such as might occur in a long gas pipeline due to uneven consumption of gas by the consumers. A highly complicated equation is obtained for the pressure in the pipeline. Unfortunately there is no comparison of these results with practical measurements. G. D. F.

586. Dracone flexible barge. W. R. Hawthorne. *Engineer, Lond.*, 1961, **211**, 156–61.—Account of technical development with numerous diagrams showing constructional details and discussion of hydrodynamics involved. Tabulation of trials of 18 Dracones. V. B.

REFINERY OPERATIONS

REFINERIES AND AUXILIARY REFINERY PLANT

587. Design factors for lined vessels and piping. H. Thielsch. *Petrol. Engr*, Dec 1960, **32** (13), C50.—The protection of plant can be carried out by means of thin liners of expensive stainless steel or non-ferrous alloys. Methods of lining by plug welding, strip welding, and through welding are discussed. Pipes are usually lined by strip-welding techniques. Design aspects are outlined. G. D. F.

588. Problems in research on materials for the construction of chemical plant. (In German.) K. Richard. *Chem. Ing. Tech.*, 1961, **33**, 1.—It is shown that frequently ideal materials are not available for the construction of plant. In this case frequent testing during operation is required. This paper deals with actual problems in plant construction, including stress determination, the calculation of wall thickness, plating and cladding, strength at elevated temp, toughness and elasticity under operating conditions, corrosion in fluid media, corrosion of steel in hot gases, welding problems, safety problems, quality control, etc. 36 refs. G. D. F.

589. Constructional features and possibilities of the application of chemical pumps. (In German.) F. H. Middeldorf. *Chem. Ing. Tech.*, 1961, **33**, 31.—Some pumps of special design are reviewed. Included in the review are pumps with sliding ring seals, with split-tube motor drives, and special process pumps for the refining industry. Experience gained in the application of such pumps is mentioned. Finally, the interchangeability of parts is considered for three series of pumps (of German manufacture). G. D. F.

590. Heat exchange in air coolers. (In French.) Anon. *Bull. Ass. franç. Tech. Pétrole*, 1960, 862–74.—Although heat transfer film coeff (h_i) for air $\ll h_i$ water, forced air coolers can compare with those using water due to higher permissible coolant flow rate, increased area due to fin addition, and lower fouling factors. Film coeff are derived for air/fin tubes and corrections given for log mean temp difference and numbers of tube rows. R. D. M.

591. Special joints for tubes used in Lacq gas exploitation. (In French.) P. Aubert. *Bull. Ass. franç. Tech. Pétrole*, 1960, 897–916.—High pressure of Lacq gas (650 kg/cm²) has necessitated development of special joints for tubes and casing, with high rigidity and gas sealing properties. Former is achieved principally by use of trapezoidal screw threads and latter by bevelled matching faces. High standards of machining are required. Details are given of joint construction, inspection, and mechanical properties, and of necessary lathes. R. D. M.

592. Mass transfer. (In French.) D. Defives. *Rev. Inst. franç. Pétrole*, 1960, **15**, 1142–69, 1347–65, 1446–64.—I. General considerations on continuous media. (i) Continuous system. (ii) Velocities and fluxes. (iii) Diffusion. (iv) Equations of continuity. II. Mol diffusion. (i) Causes. (ii) In binary mixture. Fundamental hypothesis. Definition of mol diffusion. (iii) Application of the equation of continuity. (iv) Determination of diffusion coeff. III. Transfer coeff. (i) Definition. Sherwood's and Margoulis' Nos. (ii) Examples in a stationary fluid. (iii) Examples in a perfect fluid in motion. (iv) General expression of Sherwood's No. (v) Turbulent diffusion. (vi) Transfer between a solid wall and a fluid. (vii) Transfer between two fluids. IV. Transfer units. (i) General considerations on continuous countercurrent contact. (ii) Transfer units—Height Transfer Unit. (iii) Determination of number of transfer units.

(Author's abstract.)

593. *Petroleum Times* annual refinery survey. Anon. *Petrol. Times*, 13.1.61, **65**, 5–24.—Refinery statistics as at 1 Jan 1961 are presented for W Europe, Africa, Middle East, Far East, Oceania, Latin America, and the Caribbean. Details are given of current refining capacity by company and refinery, reporting the types of products manufactured and the main refining units employed. The location of each refinery is shown on a map, and present and future refinery construction is detailed. A. D. S.

594. *Petroleum Times* refinery equipment review. Anon. *Petrol. Times*, 13.1.61, **65**, 25–78.—This review covers the contribution of the U.K. equipment industry to refineries during 1960. It includes details of orders executed for refineries either in the U.K. or abroad and of new products introduced during the year which have application to refinery construction or operation. Also included are such aspects as licensing arrangements, formation of new companies or subsidiaries, etc., in so far as these relate to refineries. A. D. S.

DISTILLATION

595. Process for the recovery of pure aromatics from hydrogenation raffinates and reformates. (In German.) K-H. Eisenlohr and J. Wirth. *Chem. Ing. Tech.*, 1960, **32**, 789–801.—The paper presents a general survey on methods available for the recovery of pure aromatics from various raw materials. Among the methods considered for the separation of aromatics from paraffinic and naphthenic hydrocarbons are fractional, extractive, and azeotropic dist and liq–liq extraction. Each process is discussed by means of flow sheets, and mention is made of the applications and limitations of each. 28 refs. G. D. F.

ABSORPTION AND ADSORPTION

596. New process produces liquid sulphur directly from sour gas. Anon. *Oil Gas J.*, 26.12.60, **58** (52), 165.—A new sulphur recovery process using synthetic zeolite by-passes one step in the conventional method of producing sulphur from sour natural gas. The adsorbent, calcium aluminosilicate, is an excellent Claus cat and when saturated with H_2S can be regenerated at 600° F with hot sulphur-burner gases to produce sulphur and water vapour. The liq sulphur is recovered by condensation of these vapours.

It is estimated that the cost of a plant for treating 8 MMcfd of sour gas containing 15% H_2S would be *ca* $600,000. Cooling water is the only essential utility, since the plant derives its energy requirements from the sour portion of the inlet gas. A. D. S.

SOLVENT EXTRACTION AND DEWAXING

597. Measurement of the "volume-fraction" of liquid–liquid dispersion by conductimetry. Application to pulsation column. (In French.) D. Defives *et al. Chim. et Industr.*, (*Génie Chim.* suppl.) 1960, **84**, 120–9.—Relationship between vol fraction (x) and ratio (λ) of electrical resistances of pure continuous phase *Ro* and of dispersion *R* is determined for hydrocarbon/aqueous systems in a vessel fitted with two perforated plates acting as agitators and as electrical contacts. Results agree with those of previous workers. Technique is applied to a running modified pulsation column. *R* of section under test is measured and section is then isolated and x found by settling. *Ro* of continuous phase is then measured. Values of x found from λ agree with those found directly,

except near distributor, where dispersion is perhaps insufficient. R. D. M.

CRACKING

598. What you should know about catalytic cracking. 2. Fluidization. J. F. Crocoll and R. D. JaQuay. *Petrol. Engr*, Dec 1960, **32** (13), C26.—The cat fluidization or flow patterns are very important in the performance of the cracking process. Cat flow patterns in three different designs of commercial units are discussed. Gas flow patterns have also been determined and are discussed. Various effects during cat cracking in the reactor and regenerator are detailed. Numerous refs. G. D. F.

599. Moving bed catalytic cracking. 2. Applied process and mechanical design procedures. A. W. Hoge, R. E. Ashwill, and E. A. White. *Petrol. Engr*, Dec 1960, **32** (13), C32.—This part presents the design procedures for specific elements of the HB Houdriflow unit, which illustrates the application of the fundamental mechanisms. The elements considered include top seal leg design, reactor oil feed system, reactor bed design, vapour disengager design, purge zone design, kiln design, and cat lift system design (in detail). There are considerations of mechanical design aspects and operability and control. There are also brief mentions of recent improvements in moving bed cracking cat and of investment and operating costs. G. D. F.

600. Advances in cracking catalysts. B. H. Loper and R. M. De Baun. *Petrol. Engr*, Dec 1960, **32** (13), C20.—The various cat, synthetic and natural, which have been available and which are available at present are compared under the following headings: activity, activity–stability, selectivity, changes in properties on use. The physical properties, such as particle size, shape, density, heat capacity, etc., are also discussed. The regenerability of various cat are compared also. The economics of cat choice are outlined briefly. G. D. F.

601. Thermal cracking of hydrocarbons by the Koppers process. (In German.) P. Schenk. *Erdöl u. Kohle*, 1959, **12**, 717–22.—In 1956 the H. Koppers installation for producing town gas from mineral oils was put into operation with an output of 60,000 m³/d. Feeds were all hydrocarbon fractions from liq gas over light gasoline and crude oil to heavy oil. Paraffins and naphthenes are most suitable. For judging the feed boiling behaviour, visc course, Conradson test, elementary analysis with information on C/H ratio are important. In the simplified scheme the hydrocarbon chain is split at *ca* 750°–850° C, giving a high-cal val and olefin-rich cracked gas. Important factors for cracking degree and intensity are temp, residence time, and special material properties of the feed. The primary cracking is controlled easily but does not produce normal town gas. Secondary cracking is necessary to obtain an exchange gas corresponding to conventional coal gas–water gas mixture, namely, conversion with steam at sufficient rate above 1000° C. The process is discussed in detail, supported by plant illustrations and a flow sheet. R. T.

SPECIAL PROCESSES

602. Disposal of refinery acid sludge. I. P. W. Sherwood. *Petroleum, Lond.*, 1961, **24**, 22.—Economic and pollution considerations make it unfeasible to dump acid sludge. This paper considers various possibilities for its disposal. It is shown that acid sludges obtained from different processes vary widely in composition. The first possible use considered is the use of acid sludge (usually together with other fuel) for firing a boiler. Some of the problems encountered are mentioned. Secondly, the sludge may be hydrolysed, producing a fuel oil layer and an inorganic layer containing most of the sulphuric acid, which may be used as such (*e.g.* for pickling) or re-concentrated. Various processes for upgrading this dilute acid are given. Alternatively, given suitable markets, the acid can be converted to ammonium sulphate, for use as fertilizer. G. D. F.

603. Biological purification of effluent at Canadian refinery. Anon. *Petroleum, Lond.*, 1961, **24**, 26.—The processes used at the Trafalgar refinery of the Cities Service Oil Co for the treatment of effluent containing traces of oils and phenols is described. Briefly, oil traces are removed by flocculation, and phenols are dealt with by means of a biological purification process, which is described. The final product is claimed to be fit to drink, and is returned to Lake Ontario. G. D. F.

604. Amine units sweeten sour gas in the field. G. Ellis. *Petrol. Engr*, Dec 1960, **32** (13), B68.—It is shown that the amine process is the most popular for sweetening gas streams free of a carbonyl sulphide. A typical amine process is explained by means of a flow diagram. The chief drawbacks of the amine process from the expense point of view are corrosion and amine loss. These problems are examined carefully, and several control measures are recommended. G. D. F.

605. Peracetic acid process opens way to wide range of epoxides. D. H. Stormont. *Oil Gas J.*, 19.12.60, **58** (51), 78–9.—Union Carbide Chemicals Co have recently started their 10 million lb pa plant for producing peracetic acid and thence epoxides. The peracetic acid is synthesized by the autoxidation of acetaldehyde in a two-step process, the peracetic acid being recovered as a 30% soln in ethyl acetate. The acid is then reacted with various olefins to make a wide range of epoxides.

Safety precautions taken in the peracetic acid manufacturing stage include a close check for heavy metal contaminants which could result in explosions, an independent power source in case of failure of the normal supply, and isolation of various process stages by thick concrete walls. A. D. S.

606. Results of processing heavy gasoline from German crude oil in a platforming installation. (In German.) H. Pietsch and B. Fritz. *Erdöl u. Kohle*, 1959, **12**, 712–17.—Super power fuels are produced successfully in cat reforming installations —*e.g.* platforming—from low-ON dist. In improving heavy gasoline from German crude oil change in composition of end and intermediate products depends on the sharpness of processing conditions. Apart from future reforming gasoline with ROZ 95 or higher being considered as raw material for further special gasoline cuts, a series of profitable components is available for chem use. The reforming process also presents a cheap source of high-% H_2-gas, indispensable for further processing in chem industries. At present desulphurizing and hydrogenating installations for gasoline and gas oil are switched on to the reforming installations. Soon the H_2 will be required to operate isomerization installations with Pt-base-cat, especially where reforming and cracking capacity is inadequate, or where cracking capacity fails—*e.g.* in a new refinery—and it is necessary to convert the C_5H_{12} or C_6H_{14} into valuable gasoline components. In this connexion it will be necessary to increase the H_2 concn in the gas by suitable absorption methods within the working operation, although the H_2 cont in the production gases decreases with increasing cat life period. 13 refs. R. T.

PRODUCTS

CHEMISTRY AND PHYSICS

607. Metal-free Octane Number improvers. (In German.) E. G. Nottes. *Erdöl u. Kohle*, 1959, **12**, 635–40.—TEL remains to-day one of the most important improvers. Aromatic amines—effect < TEL/unit wt—are marked knock retarders. Joint use of TEL and monomethylaniline in current German aviation gasoline is reported. Effects of TEL and monomethylaniline on pure hydrocarbons (*n*-heptane and *iso*-octane) differ widely. Monomethylaniline subdues intermediate reactions which lead to cold flame formation in the motor. Examination of the two groups of knock-retarders shows that S-cpds impair the effect of metallo-org knock-retarders, especially of TEL, aromatic amines practically do not. Aromatic amines in their ON-increasing effect are very sensitive to peroxides, TEL less sensitive. Since the first oxidn stage of unsaturated hydrocarbons, *e.g.* cracked gasolines is peroxide formation, long-stored gasolines should not be treated with aromatic amines. Peroxides formed decompose further into aldehydes and acids. Reactions between peroxides, acids, and aldehydes with amine addition lead to gum formation. 37 refs. R. T.

608. New results of dielectric measurements on hydrocarbons. (In German.) V. F. Oehme. *Erdöl u. Kohle*, 1959, **12**, 623–7.—Non-electrolytes introduced into an elec field undergo a change. Under the effect of the field—principle of attraction of unlike charges—the electron cloud of individual atoms or mol is displaced in the field direction. The positive core of the atoms or ions is displaced opposed to the field direction. Polarization occurring is termed displacement polarization and leads to induced dipole formation. Or, in polar mol the present permanent dipoles undergo in the field an orientation producing an orientation polarization. Tech measurement of both effects is attained from the different nature of the frequency dependence of the displacement or orientation polarization. These observations permit the following conclusions. That a non-polar hydrocarbon (hexane or benzene) shows up to optical frequencies a quasi-const $DK\epsilon'_0$. Introduction of polar substances (oxy-oxo-carbonyl and carboxyl groups) effects a dispersion range. A crit frequency ω_e can be measured. Reactions which lead to increase of mol radius a or visc η displace ω_e to low frequencies. Vol of ϵ' and ϵ'' at crit frequency is a function of the number of polar substituents and their opposed reciprocal action. Dependence of dielectric characteristics number on structures and composition of hydrocarbons and hydrocarbon mixtures is presented in numerous examples. 15 refs. R. T.

609. Flame propagation in combustible gas mixtures at atmospheric or lower pressures. (In French.) J. Combourieu. *Rev. Inst. franç. Pétrole*, 1960, **15** (7–8), 1–64; (9), 65–102.—Method using a tube has been adapted for measuring the normal flame velocity of combustible gas mixtures in the low pressure zones. With a vertical tube flame front has the symmetry of revolution round the tube axis at pressures < critical val, dependent on mixture type, tube dia, and direction of flame propagation. High degree of reproducibility of uniform flame displacement enabled very clear-cut photographs to be taken of the flame front profiles with a specially designed camera, and their areas have been accurately calculated. Influence of pressure on normal flame velocity of widely varied mixtures has been measured, independently of the wall effect, and obs results are discussed in the light of different theories of flame propagation. Conditions governing stability of the flame front are interpreted with the aid of theories of flow similitude. 139 refs.

(Author's abstract.)

ANALYSIS AND TESTING

610. Oxidation behaviour of mineral oils. (In German.) H. Luther *et al.* *Erdöl u. Kohle*, 1959, **12**, 619–23, 728–33, 898–903. Pt I. Apparatus and measuring methods. Pt II. Comparison of results by chemical and spectroscopic methods. Pt III. Results of oxidn tests and oxygen balance.—Pt I. An apparatus is illustrated and described in which oxidn of high-bp fractions is determined. O_2 consumption, reaction temp, CO and CO_2 formation are registered. H_2O, low- and high-mol wt org oxidn products are analysed by conventional chem methods, gas chromatography, and ir spectroscopy. Pt II. Results of chem and ir-spectroscopic analyses are compared. Simple relationships are found between neutralization, saponification, and carboxyl number and band extinction of some key frequencies of O_2-cpds. Crit judgment of the methods is undertaken. Pt III. An addition-free motor oil (SAE 10) was aged at temp between 80° and 130° C with addition of 0·01–0·05 wt % Cu naphthenate. Chromatographic separation shows no preferred oxidn of definite hydrocarbon groups under the selected conditions. The amount of individual oxidn products was proportional to the O_2 consumption if the val had exceeded 400 ml O_2/100 g oil. Evaluating relationships found between cpds formed and O_2 consumption, a general valid balance of O_2 distribution on the reaction products was drawn up. With increasing O_2 consumption it approached asymptotically the following val (% of converted O_2): CO_2 12·5; CO 2·0; H_2O 42·5; acids 8·5; esters 13·5; carboxyl groups 9·0; ether cpds 7·0; hydroxyl (OH) groups 2·0; undeterminable substances or loss 2·5. 47 refs. R. T.

611. Hydrocarbon-containing gas analysis by gas chromatography. (In German.) G. Scharfe. *Erdöl u. Kohle*, 1959, **12**, 723–8.—Details are presented of a chromatographic apparatus consisting of 12 columns connected by four-way cocks, in which each analysing unit and a bridge instrument form an independent gas chromatographic unit. With this apparatus it is possible to detect 0·01% normally, in special cases 0·001% in a random mixture consisting of gaseous hydrocarbons and inorg gases H_2, N, O_2, CO, and CO_2. Column fillings and instrumentation are described. The apparatus is suitable for mass analyses. Seven refs. R. T.

612. Conductimetric titration of organic salts in benzene–alcohol medium. J. Larbre and J. Briant. *Rev. Inst. franç. Pétrole*, 1960, **15**, 1170–80.—Conductimetric titration of neutral and basic Ca sulphonates and Ca phenates can be effected in 50/50 w/w C_6H_6/EtOH with alc $C_2H_4O_2$. Typical titration graphs are reproduced; they consist of straight lines having different slopes, equivalence points (eq pt) being at the intersections of adjacent lines. For neutral Ca sulphonates only one eq pt occurs, corresponding to total Ca content. For basic Ca sulphonates the first eq pt gives the basic Ca, the second eq pt total Ca. For one basic sulphonate tested total Ca was < amount found gravimetrically; correct figure was obtained by adding HCl, which eliminated the first eq pt. The difference in the total Ca obtained by the two methods was believed to be Ca present colloidally as CO_3^{--}, but precision of this figure was doubtful due to inhomogeneity of sample. Titration graph for Ca phenate gave several apparent eq pt dependent on speed of titration; all except the final eq pt were eliminated by pre-treatment with HCl. A mixture of Ca phenate and sulphonate gave two eq pt corresponding to the two salts. A sample of neutral Ba sulphonate was successfully titrated, but adsorption on pptd Ba oxalate caused considerable drift from the straight lines. By comparison with curves obtained by potentiometric titration of

basic Ca sulphonates with alc H_2SO_4 superiority of conductimetric method for determination of basicity or weak acidity of Ca detergents is shown. The conductimetric method, which requires only a few mg of sample, may have wider applications. W. A. M.

613. More sensitive test method for determining the dielectric strength of insulating oil. P. F. Ast. *Bull. Amer. Soc. Test. Mat.*, 1960, 214–17.—Spherically-capped VDE type electrodes, horizontally mounted, spaced 0·081 inch in approx cubical 1 l capacity vessel; motor-driven impeller (lowering breakdown to *ca* 80% of value with non-circulating oil). Voltage rise from zero at $\frac{1}{2}$ kV/sec. Six breakdowns, disregard first, average remaining five. Round-robin tests in 16 lab, each using own oil and comparing (11 lab) with ASTM D877-49. New test is more sensitive; D877 shows no change in elect strength for H_2O up to 60% of saturation (*ca* 30/35 ppm), whereas new method gives linear decrease of elect strength with increasing H_2O content. Tests with 0·040-inch gap also reported. V. B.

614. Radio-elements in the petroleum industry. (In French.) J. Thiéry. *Rev. Inst. franç. Pétrole*, 1960, **15**, 1181–96.—Review of the uses of radioactive sources in the petroleum industry. In the field these include well logging, control of water flooding, cementation and acidification, location of permeable structures, and measurement of drainage rates. Uses in transportation include examination of pipeline welds, location of pigs, leaks, and boundary between successive products. On the refinery liq levels in tanks and vessels and flow-rates can be monitored; other applications include observation of cat movements and of plate equilibria in dist columns, detection of coke-forming constituents of cracking stocks, and elimination of electrostatic charges during transfer. Evaluation of wear tendencies of lub oils and additives can be carried out speedily and accurately using radioactive engine components; coke formation in engines can be similarly studied using labelled fuels and lubricants. Other applications include studies of reaction mechanisms, *e.g.* combustion, oxidn, and analyt uses, *e.g.* determination of C/H ratio, S, TEL, Na, and Cl. 74 refs. W. A. M.

GAS

615. Physical deliverability of gas reserves. I. I. Gardescu. *J. Petrol. Tech.*, Dec 1960, **12** (12), 25–9.—Recoverable reserves give the ultimate vol of gas which can be produced profitably, generally with no restriction on the period or rate of flow. Deliverable reserves are those which a field or well can give in a fixed time at a specified contractual rate against a certain well-head pressure. For the Knox field of Grady and Stephens County, Oklahoma, the Bromide dry gas recoverable reserves are estimated as 245,943 MMcf, being 82·5% of the original gas in place, whereas the deliverable reserves over 20 years are calculated as 171,820 MMcf (actual gas produced 198,870 MMcf before extraction of liq hydrocarbons).

Permeability is an important factor in fixing the difference between recoverable and deliverable reserves. Low permeability reduces the present-day value of gas reserves.

The detailed computations for the deliverable reserves are set out, and the deliverability schedule is given. The back-pressure potential curve was based on data for ten of the wells. It was estimated that when the reservoir falls below the condensate dew point the liq deposited will reduce the effective permeability. G. D. H.

616. Cheap inert gas—new operating medium. (In German.) G. von Bennigsen. *Erdol u. Kohle*, 1959, **12**, 646–8.—The new protective gas installation, illustrated, produces an inert gas distinguished by its low O_2-cont and startability. It requires rigid regulation and instrumentation control. Inert gas produced is suitable for purging pipes and containers and as supporter gas, also for fire combating. R. T.

617. The go-ahead for Canadian natural gas. Anon. *Petroleum, Lond.*, 1961, **24**, 16.—Canadian gas production has increased some 380% in four years to reach *ca* 1475 Mcf/day in 1960. A map shows existing pipelines, and a newly proposed 1400-mile line, running roughly from Edmonton to San Francisco. The paper shows that new finds of gas continue to be made in Canada. G. D. F.

ENGINE FUELS

618. The part played by the preparational stage in determining lead anti-knock effectiveness. D. Downs, S. T. Griffiths, and R. W. Wheeler. *J. Inst. Petrol.*, 1961, **47**, 1–17.—At least two processes make up the overall anti-knock action of TEL—the "preparational," which ensures that the organic mol decomposes to PbO at the right time and in the right form for max effectiveness, and the "inhibiting," which determines the inherent anti-knock capabilities of the PbO in the given set of circumstances.

To investigate the preparational stage, an electromagnetically-operated sampling valve was used to extract samples of gas from the combustion chamber at different times in the cycle. Analysis of these samples enabled the decomposition of TEL to inorganic lead to be followed. Motored engine experiments were also carried out to provide information on the cool and hot flame limits and cool flame intensities of the fuels used. A preliminary experiment using a Tyndall beam technique showed that a fog of inorganic lead particles is formed in the engine cyl sufficiently early to influence the chemical reactions leading to knock.

The investigation has shown that fuel type has an important influence on the decomposition of TEL from the organic to inorganic phase. Under fixed engine conditions the higher the knock rating of the fuel, the later the TEL decomposition. It appears that the cool flame plays some part in decomposing TEL to the active form. When the severity of engine operating conditions is increased by raising the CR to the knock limit in all cases the TEL decomposition is advanced to a sufficiently early timing to ensure the presence of a lead fog during the knocking reactions. This occurs even with fuels of poor lead response such as benzene and methanol, and even addition of ether to these fuels, which increased lead response, had little or no effect on the timing of TEL decomposition.

It appears that the inhibiting stage is probably more important than the preparational one and will be dealt with in a later paper. A. D. S.

619. Determination of diesel fuel cetane number in the BASF test diesel. (In German.) W. Wolf. *Erdöl u. Kohle*, 1959, **12**, 740–3.—Ignition of diesel fuels is examined in the BASF test diesel. The relatively simple aggregate has proved its suitability in later years in numerous comparative and ring determinations, and is used increasingly at home and abroad. Ignition lag measurement, up to now with the help of a nozzle–needle–contact transmitter and inertia transmitter with glow-lamp indicator could be simplified and improved by using an electronic ignition lag-measuring instrument. In carrying out the cetane estimation with the fixed const ignition lag given in DIN 51773 of 20° KW the BASF test diesel shows a range of measurement for cetane number of *ca* 25 to over 100. 11 refs. R. T.

620. Petroleum as an electrochemical fuel. (In French.) J. C. Balaceanu. *Rev. Inst. franç. Pétrole*, 1960, **15**, 1465–79.—Consideration of thermodynamics and efficiency of conversion of chem energy to mechanical energy by conventional

routes is followed by description of two types of fuel cell in which chem energy of oxidn of H_2 or hydrocarbon gases is converted directly to elec energy with an efficiency of 60–70%. 26 refs. W. A. M.

LUBRICANTS

621. Why engine lubrication fails. Pt 2. D. H. Moore. *Oil Gas J.*, 19.12.60, **58** (51), 109–11.—The delivery of an oil pump is a function of the cross-sectional area of the plunger, the number and length of the strokes, and the pump efficiency. Knowing the plunger size and the speed of the lubricator shaft, it became necessary only to devise a means of measuring the length of the plunger stroke to get a delivery rate. Ways of accomplishing this with different types of pumps are described, and the cost for modifying approx 2000 pumps was found to be *ca* $75.

Calibrating the reservoirs and setting the stroke to match the daily make-up will definitely give a more equitable distribution of oil to the lubrication points. A. D. S.

622. How to get better lubrication. Pt 3. O. H. Moore. *Oil Gas J.*, 2.1.61, **59** (1), 104–6.—Whilst modification of equipment, as described in the previous parts of this paper, is one way to improve engine lubrication, other less drastic methods can contribute. These include mechanical maintenance, checking the lubricator drive, correcting oil delivery for changes in pressure and temp, use of distributor blocks, installing O-rings, and employing better-trained personnel. A. D. S.

623. Modern fire-resistant hydraulic fluids for industrial use. H. A. Snow. *Sci. Lubric.*, May 1960, **12** (5), 39–42.—Applications for fire-resistant hydraulic fluids are set out, and the four basic types, petroleum, emulsion fluids, water–glycol mixtures, and phosphate esters, are compared from the standpoints of fire resistance, lubricity, viscosity–temp, characteristics, and cost. Selection, installation, and maintenance are briefly discussed. J. G. H.

624. Jet and space age lubrication. E. B. Palmer. *Sci. Lubric.*, Feb 1960, **12** (2), 12–17.—The functions of aircraft lubricants in the extreme conditions encountered with modern equipment are outlined, and special problems arising from operation at supersonic speeds are indicated. Present available range of aircraft lub fluids is presented, with advantages and limitations of specific lubricants. Radiation-resistant lubricants and solid film lubricants, especially polytetrafluoroethylene, are discussed, together with vapour lubricated bearings and the possibilities of ceramics and ferretic iron compositions. J. G. H.

625. What to look for in chemical cutting and grinding fluids. P. W. Sherwood. *Sci. Lubric.*, Sept 1960, **12** (9), 25–6.—Properties and limitations of soluble cutting oils are enumerated, and the advantages of chemical cutting and grinding fluids incorporating rust inhibitors, lub agents, germicides, wetting agents, and water conditioners are discussed with special reference to residue formation. J. G. H.

626. Lubrication of bearings at high temperatures. E. G. Ellis. *Sci. Lubric.*, Sept 1960, **12** (9), 16–23.—Recent literature on the lubrication of bearings at high temp is reviewed under the headings of bearing materials, liq, vapour phase and solid lubricants, chemically-reactive gases, liq metals, dry operation, gas lubricated bearings, and oil mist operation. 15 refs. J. G. H.

627. Disposal of waste soluble-oil emulsions. Mobil Oil Co. *Sci. Lubric.*, Feb 1960, **12** (2), 30–2.—The relation between permissible oil content for disposal and emulsion composition is indicated. Main methods of disposal are briefly described, with a more detailed treatment of emulsion breaking with acid or acid salt. J. G. H.

628. Controlling the spoilage of water soluble cutting fluids. C. D. Flemming and R. J. Baker. *Lubric. Engng*, 1960, **16**, 414–19.—The magnitude of the problem of the spoilage of soluble oil emulsions is emphasized, and spoilage characteristics are set out, together with conditions favouring spoilage. Sulphate-reducing anaerobic bacteria were found to be responsible for most cases of spoilage; their sources and environmental conditions are discussed in some detail. Other contributory causes, electrochemical action, and contamination with iron fines produced during machining are considered. Grinder and bottle tests for spoilage are set out, and spoilage control measures are suggested. J. G. H.

629. Nitroparaffin inhibitors for cutting fluids. E. O. Bennett and H. N. Futch. *Lubric. Engng*, 1960, **16**, 228–30.—Details are presented of an investigation of the effectiveness of nitroparaffin derivatives as inhibitors of bacterial deterioration of cutting fluids using tris nitromethane as a standard. Materials and methods used are described. Detailed results obtained with 16 cpds found to be particularly effective are set out and potentialities indicated. J. G. H.

630. New approach to the lubricating problems of internal combustion engines. F. A. Kirigin. *Lubric. Engng*, 1960, **16**, 315–20.—It is suggested that a better understanding of IC engine processes and requirements for optimum operation will be obtained by a wider knowledge of the isolated physical and chemical phenomena occurring in the working engine and by envisaging the interlacement of such phenomena. In this manner a new approach to lubrication problems is indicated and illustrated by application to the CI engine. J. G. H.

631. Centralized re-circulating coolant systems for cold rolling operations in the steel and aluminium industries. J. P. Wettach. *Lubric. Engng*, 1960, **16**, 410–13.—Recent expansion and technical developments in cold rolling operations have placed an added responsibility on the centralized coolant systems. Factors governing the size of the system are set out and the main components, reservoir, pumps, and filters are discussed in detail, with reference to special requirements in rolling particular metals. J. G. H.

632. Emulsified rust preventives. H. B. Carpenter. *Lubric. Engng*, 1960, **16**, 360–2.—The development of petroleum base rust preventives is briefly described, and details are presented of the formulation of emulsified preventives based on proven rust preventives. Lab evaluations indicating satisfactory performance are summarized and methods of application are set out. J. G. H.

633. Service evaluation of detergent lubricating oils utilizing electron microscopy. S. R. Rouze and F. A. Forster. *Lubric. Engng*, 1960, **16**, 222–7.—Previous work indicating that the effective detergency level in used lub oils could be determined by electron microscopic examination of dispersed solids has been continued to explore the possibility of following the detergency level remaining in such oils by electron microscopy rather than by the periodic inspection of engine parts. This was done, and on electron microscopic indication that detergency was lost, the oils were changed with satisfactory results on final inspection. Test methods, sampling procedure, and results obtained are discussed in detail. J. G. H.

634. Grease worker results and their significance in anti-friction bearing lubrication. E. Sillett. *Lubric. Engng*, 1960, **16**, 477–80.—Lack of correlation between lab results and field experience has resulted in some criticism of grease worker

tests as an indication of reliability in the lubrication of anti-friction bearings. Investigations here reported indicated the need for closer co-operation between service inquiries and lab personnel. Presence of vibration and overpacking of bearings with grease have been contributory factors in criticism of the test which, it is concluded, remains valid. J. G. H.

635. Glacier's Anti-Whirl turbine bearing. Anon. *Sci. Lubric.*, Feb 1960, **12** (2), 17–18.—A new turbine bearing developed by Glacier Metal Co Ltd, specially designed to avoid oil whirl and foaming in turbo-alternator generating sets, is described and illustrated. J. G. H.

636. Petroleum hydraulic fluids. S. F. Chisholm. *Sci. Lubric.*, May 1960, **12** (5), 35–8.—The principles of hydraulic actuation of machinery are outlined and the desired properties for a hydraulic fluid are set out and discussed with reference to the accepted tests for these properties. Maintenance problems encountered in hydraulic systems are touched on. J. G. H.

637. Operation of rolling element bearings in a protective atmosphere. A. G. Cattaneo, R. A. Coit, and S. S. Sorem. *Sci. Lubric.*, April 1960, **12** (4), 26–8.—Marked increases in operating temp of many types of modern equipment, in some cases up to 1100° F, call for protection against two types of early failure in rolling element bearings involved—formation of red oxide by oxygen surface attack and rapid wear by local seizure or scuffing of the cage surfaces in sliding contact with other elements. While blanketing with nitrogen or other inert gases delayed failure, it did not act as an effective preventive. Promising results, however, were obtained by the addition of a hydrocarbon vapour or other organic reducing agent to the atmosphere in the bearing in stoichiometric excess over the available oxygen. Adequate anti-scuffing protection called for further investigation. J. G. H.

638. Rapeseed oil as a component of lubricating grease. J. Grindrod. *Sci. Lubric.*, March 1960, **12** (3), 21–4.—Use of rapeseed oil as a substitute for 12-hydroxystearic acid in the formulation of lithium greases is briefly described.

Cultivation of rape and properties of rapeseed oil are discussed and results of field tests by Western Oil Co of Canada are presented. J. G. H.

639. Developments in production of lubricating grease. J. Grindrod. *Sci. Lubric.*, March 1960, **12** (3), 18–20.—Post-war developments in the constituents of lub greases are briefly described, together with the use of special purpose additives.

Principal manufacturing processes are touched upon, with special emphasis on the function of milling. The chemical and physical characteristics of the atoms and molecules of grease are discussed in so far as they affect its behaviour, together with the directional fluidity and the formation of "grease wedges." J. G. H.

640. Fundamental processes in lubricating metal surfaces at 100° F to 1700° F. E. N. Klemgard. *Lubric. Engng*, 1960, **16** (10), 468–76.—Results are reported of an investigation into the processes occurring in nickel alloy–solid lubricant systems operating in air within the 100°–1700° F range, friction, wear, and surface damage involving multi-component solid lubricants containing graphite, boron oxide, silver chloride, silver fluoride, metal phthalocyanine, molybdenum disulphide, lead oxide, and sodium silicate being calculated. Controlling processes are indicated as physical and chemical changes in the surface layers, changes in the metal substrates, and changes in bulk lubricant film with high temp effects, including variable yield and shear strength and hardness and diffusion of the substrates. Chemical reactions, decomposition, oxidn, reduction, and combination occur in the surface and bulk films and two or more processes functioning simultaneously lead to complex friction–temp relationships. Seven refs. J. G. H.

641. Lubrication maintenance of hydraulically-operated automobile transmissions. P. Richardson. *Sci. Lubric.*, May 1960, **12** (5), 53–8, 62.—Types of hydraulically-operated automobile transmissions are described and illustrated.

Basic features of hydraulic operation are outlined and the functions and properties of the transmission fluid are discussed, together with maintenance requirements. J. G. H.

642. Axle and gearbox lubrication and the development of trans-axle fluid. E. G. Ellis. *Sci. Lubric.*, Aug 1960, **12** (8), 27–32.—Difficulties encountered in the use of a common lubricant for gearbox and back axle are discussed and the introduction of the trans-axle combination is described. Development of a suitable lubricant is described, fluid evaluation, shear stability, the inclusion of additives, and the effect of transmission and axle design being considered. Eight refs. J. G. H.

643. Lubrication of spur wheel gears. (In German.) J. R. Hughes and F. H. Waight. *Erdöl u. Kohle*, 1959, **12**, 630–5.—No process exists for calculating the limit load supportable by an oil film under given conditions. The present work contains a series of test results on spur wheel gears in the illustrated apparatus. Details of gears and test method are given in IP tentative method 166/58T. Straight mineral oils and those with additives are compared. Theories presented in eqn are discussed critically and compared with present results. Influences discussed are oil temp and visc on bearing capacity, speed, and temp. Causes of scuffing, scoring, and pitting are discussed. 14 refs. R. T.

644. New circulation procedure for evaluating motor lubricating oils. (In German.) M. Freund and S. Pallay. *Erdöl u. Kohle*, 1959, **12**, 627–30.—Procedure carried out in the illustrated apparatus is suitable for lab evaluation of motor lub oils. Results agree with those obtained on diesel and Otto motor test stands. Comparative results show that the process offers a good ref pt for choice and classification of motor lub oils. 17 refs. R. T.

645. Selection and use of diesel lubricants from the basicity aspect. (In French.) M. D. Benoist. *Bull. Ass. franç. Tech. Pétrole*, 1960, 877–94.—Relationship is shown between basicity change in additioned lubes and engine wear and fouling. Lower critical value of lubricant basicity is indicated dependent on S content of the fuel. Rate of acid formation (a) in crankcase is given by $a = 0{\cdot}35\gamma FS$; a = mg KOH/g/hr, $\gamma = \%$ age of S reacting with the oil, F = fuel consumption g/hr, $S = \%$ wt sulphur in fuel + 0·1. This is developed to give charts showing relationship between $\gamma . FS$, basicity, amount of make-up oil, and fuel consumption. In cases where oil change is decided by basicity level the intervals can be calculated. R. D. M.

646. Examples of the influence of dry and lubricated friction on modification of the surface layers of metals. (In French.) L. Pons. *Rev. Inst. franç. Pétrole*, 1960, **15**, 1480–542.—Effect on friction of physical condition of a surface and influence of this friction on changes in surface layers are considered for ferrous alloys. Analyt methods used were the metallographic microscope, micro-hardness, electron microscopy, and diffraction. Some of the ferrous alloys studied had been case-hardened by a treatment involving dispersion of the C, N, and S. Part of the S study was made with Castaing's microprobe. Friction was produced by rolling and sliding two cyl test pieces on each other or sliding a bearing on one cyl test piece (Amsler wear machine). Results

covered mechanism of wear by friction, particularly with respect to deformation and transformation of surface layers, production of twin crystals and slips. 33 refs.
(Author's abstract.)

647. Lubricating oil (heavy duty) complying with Defence Specification DEF 2101. Anon. *Sci. Lubric.*, Jan–Feb 1960, **12** (1–2), 17, 28.—A further list of oils approved by the Directorate of Chemical Inspection as complying with the requirements of the Defence Specification DEF 2101 is presented. J. G. H.

648. Lubricating oil (heavy duty) complying with Defence Specification DEF 2101. Anon. *Sci. Lubric.*, June 1960, **12** (6), 19.—A list of additional oils approved by the Directorate of Chemical Inspection as complying with the requirements of Defence Specification DEF 2101, together with a list of cancelled qualifications. J. G. H.

649. Short versions of papers presented at the ASLE 15th Annual Meeting. Anon. *Sci. Lubric.*, July–Aug 1960, **12** (7–8), 15–21, 16–26.—Abstracts of papers are presented under the following subject headings: seals and packings; hydraulics and hydraulic machinery; railroad lubrication; bearings and bearing lubrication; gears and gear lubrication; properties of lubricants; metalworking; engine lubrication; lubrication equipment; machine tool lubrication and lubrication fundamentals. J. G. H.

650. Short versions of papers presented to the ASLE–ASME Lubrication Conference. Anon. *Sci. Lubric.*, Jan 1960, **12** (1), 12–16.—Abstracts of papers are presented under the following subject headings: properties of lubricants; hydrodynamic bearings; metal working; lubrication for advanced flight vehicles; special topics; basic friction and wear, and rolling contact, fatigue, and friction. J. G. H.

BITUMEN, ASPHALT, AND TAR

651. The wetting of "air-dry" stone by bituminous binder in the road surface dressing operation. E. J. Dickinson. *J. Inst. Petrol.*, 1961, **41**, 22–34.—When using the "spray and chip" method for resealing fast, lightly-trafficked roads in dry weather, two conditions must be fulfilled for successful retention of stone. These are: the surface visc of the binder film must be sufficiently low to ensure rapid wetting of the stone, and the bulk visc must be sufficiently low during the first 24 hr after application so that the stone can move reasonably freely under the action of pneumatic-tyred traffic and form an inter-locking mosaic.

In the inland regions of the Union of South Africa the road surface temp at sunrise can, under settled weather conditions, be used to predict the temp conditions during the next 24 hr. It can thus be used as a guide to the choice of grade of binder to ensure complete retention of stone chippings. Cutback bitumens, although suitable for resealing under cold conditions, are not so effective as would be expected from their low bulk visc because of rapid evaporation of the cutting-back oil. Crude source of bitumen did not appear to have an important effect on wetting properties for air-dry roadstone, and neither addition of long-chain polymers, soluble fatty acids and esters, nor cationic wetting agents effects any significant improvement in wetting properties under dry conditions. Dust on the stone surface produced a significant reduction in the wetting rate by bitumen, but differences in stone mineral composition had only a small effect. A. D. S.

652. Investigation of a pressure-gasification tar from South African coal using a new process. (In German.) E. Terres and H. H. Hahn. *Erdöl u. Kohle*, 1959, **12**, 734–9.—Pt I. Industrial production of remote gas by pressure-gasification from coking coal began simultaneously in Germany and S Africa for producing synthesis gas from ash-rich S African coal. In pressure-gasification (20–30 atm) with O_2, steam, the resulting tars differ from low-temp-carbonization tars and require special processing. Pre-dist of the raw tar separated asphalts and asphalt-forming materials, also H_2, and, at the same time, brought about decomp into four dist fractions which represented *ca* 80% of the original tar. The original tar was divided as described into three fractions: neutral oils *ca* 57 or 66 wt %; phenols 22 or 26·6 wt %; and tar bases 5 or 4·9 wt %; loss 2·1 wt %. The fractions were submitted to fine fractionation, distribution, elution, and paper chromatography and the results presented and discussed. 11 refs.
R. T.

SPECIAL HYDROCARBON PRODUCTS

653. Testing solvents for anti-locust insecticides. A. D. Harford. *Mfg Chem.*, 1961, **32**, 12–14.—Hydrocarbon solvents used as carriers for insecticidal chemicals must be of low cost and be able to dissolve a large quantity of the pesticide. Other requirements are: a boiling range of 200°–350° C to ensure staple droplet size of the spray in the appropriate climatic conditions; a visc of not more than 12 cS at 80° C to ensure a free flow of liq in the spray nozzles; and a closed flash point of not less than 200° F for safety reasons. Aromatic petroleum extracts meet these requirements, and up to the present a high boiling solvent obtained from solvent extraction of kerosine (KEB) has been employed. With the advent of new refinery processes, a new range of products of the KEB type are becoming available.

Brief details are given of the rearing of test insects, the life cycle of locusts, and the biological testing procedure.
A. D. S.

DERIVED CHEMICAL PRODUCTS

654. Petrochemistry in U.S.A. (In French.) D. A. Shepard. *Chim. et Industr.*, 1960, **84**, 461–70.—Lecture.

655. Petroleum to plastics. (In French.) M. Moulin. *Bull. Ass. franç. Tech. Pétrole*, 1960, 819–60. Cf Abs. 116, **1961.**

COAL, SHALE, AND PEAT

656. Studies in shale oil. Part X. Tar bases and gum formation in shale gasoline. G. E. Mapstone. *J. Inst. Petrol.*, 1961, **47**, 35–7.—The condensation of pyridine homologues with quinones, ketones, or carboxylic acids can give rise to resinous products very similar in character and appearance to gum formed in crude shale gasoline and naphtha. It is suggested that similar reactions may be responsible for the rapid gum formation in these products. A. D. S.

CORROSION

657. Bacterial corrosion—a European viewpoint. L. T. Minchin. *Petrol. Engr*, Dec 1960, **32** (13), D19.—A brief historical survey of the problem of bacterial corrosion leads to a consideration of recent work. The organisms responsible for corrosion and the conditions favoured for aerobic and anaerobic corrosion are discussed. Various inhibitors have been tested, but none appear to be entirely satisfactory, by reason of toxicity, rapid disappearance, or expense. Practical preventative measures developed in W Europe are mentioned, as are pipe protection and cathodic protection. Numerous refs. G. D. F.

658. Economics of cathodic protection. F. A. Therrell, Jr. *Pipe Line News*, Dec 1960, **32**, 55.—The cost of pipeline corrosion, the cost of controlling corrosion, and recommendations for economic measures to control and maintain protection are briefly discussed in this paper. Of the five graphs presented, one is an interesting plot of the total construction cost plus cumulative cathodic protection cost per mile of a 12-inch pipe against years of service. The greatest overall economy can be realized by applying a good coating to thin-wall pipe and cathodically protecting the system by utilizing a deep groundbed facility. M. F. M.

659. New tool permits onstream refinery corrosion check-up. C. J. Lawrence. *Oil Gas J.*, 19.12.60, **58** (51), 72–3.—A new tool, the Ultragage, employs the basic principles of pulse-echo ultrasonics or sonar, and experience with it shows three main advantages. It permits onstream inspection for corrosion even on hot lines up to temp of 1000° F. The speed possible enables a refiner to get wider inspection coverage at less cost. It is more accurate than any previous corrosion inspection method, allowing measurement of wall thickness with an accuracy of 0·005 inch.

The testing method involves two pieces of equipment, the Ultragage and Ultracoupler. The latter is a scanning device and contains a crystal immersed in water. Ultrasonic pulses from the Ultragage bounce from the inner and outer walls of the test material and back through the crystal. The reflection is fed back to the Ultragage, which translates the sound on a cathode-ray screen. A. D. S.

660. Corrosion tests speeded by ultrasonics. Anon. *Oil Gas J.*, 2.1.61, **59** (1), 88–90.—Three methods are used for ultrasonic inspection: a single-frequency sound beam is transmitted through the part; the beam is reflected from changes of section or discontinuities of the part; or the sound beam frequency is varied to produce resonance. The applications, advantages, and limitations of ultrasonic testings are shown in tabular form.

Resonance is used for thickness testing and will measure thickness from a few thousandths of an inch up to 12 inches with material of good sound-transmitting properties. Accuracy is usually within 0·1–3%. The pulse-echo technique may also be used with an accuracy of ±5%, usually when thicknesses are greater than 1 inch.

Almost all flaw detection techniques use a pulsed sound beam, and types of instrument are described. A. D. S.

661. Organic corrosion inhibitors, their action and use. (In German.) G. E. Purdy. *Erdöl u. Kohle*, 1959, **12**, 743–7.—Org corrosion inhibitors are adsorbed on metal surfaces thereby lowering corrosive attack. They have a marked detergent effect. At temp up to 260° C they are usable, easily applicable, economical, and effective. In the last ten years they have found increasing application in preventing internal corrosion in petroleum and natural gas producing wells. They are used also for corrosion prevention in refinery operations and in product distributing arrangements. They are specified in the U.S.A. for military purposes, aviation gasoline, and jet fuel. Similar spec are adopted by NATO. Nine refs. R. T.

SAFETY PRECAUTIONS

662. Reduction of atmospheric pollution. (In French.) L. Fassina. *Chim. et Industr.*, 1960, **84**, 529–31.—Passing IC engine exhaust gas through a cell containing $MnO_2.H_2O$ on sawdust oxidizes CO to CO_2. Continuous air flow through cell due to vehicle movement (or pump) gives automatic cat regeneration. R. D. M.

ECONOMICS AND MARKETING

663. Key to the future—a review of the economics of the U.S. oil producing industry. G. D. Priestman. *J. Petrol. Tech.*, Nov 1960, **12** (11), 11–14.—The total income of the producing industry in a year depends on crude oil, natural gas liq, and natural gas production, and the average price of each. In 1940, 1945, 1950, and 1955 the income was \$1.22, 1.86, 4.6, and 6.87×10^9, respectively. In 1940 the income from gas was $\$0.08 \times 10^9$; in 1955 it was $\$0.88 \times 10^9$.

Expenditure is the outlay to find, develop, and produce oil. It is less easy to assess. For 1943, 1948, 1953, and 1957 the total outlay was \$1.53, 3.32, 6.23, and 7.62×10^9, respectively, the three sub-divisions requiring roughly the same amounts. 27,000 wells were drilled in 1945 and 58,000 in 1956. For the period 1953–56 the plot of expenditure exceeds that for income. Industry seems to have invested over $\$10 \times 10^9$ in spare capacity, or *ca* 20% of its total outlay in the last 11 years.

For 50 producers the return on investment was *ca* 8% pre-war, 36% in 1948, dropping to 11·8% in 1958. Over most of the period the industry's figures were below those for the 50 producers. Replacement costs, in terms of 1958 dollars, were \$1.57/brl in 1940, rising to \$2.93/brl in 1957; finding costs rose from \$0.26/brl in 1940 to \$0.78/brl in 1957. Crude oil prices in 1958 dollars have had a downward trend since 1948.

65% of finding and development costs are associated with drilling the wells. The return on net assets and the replacement cost do not indicate the results of efforts at any one time; return on new investment gives an indication. Return on replacement cost basis was 15% in 1940, falling to 5% in 1958. G. D. H.

664. Probable pattern of United States petroleum supply. K. E. Hill. *J. Petrol. Tech.*, Nov 1960, **12** (11), 15–17.—The U.S.A. is the world's largest oil producer, and also uses over half of the world's production. U.S. prices are the main influence on crude and product prices throughout the world. In the next few years U.S. consumption is expected to grow at 4% pa, and then more slowly, because of cheaper natural gas, slower industrial expansion, and slower growth in gasoline

use. By 1975 the domestic demand for petroleum liq may be 17×10^6 bd, compared with 10×10^6 bd now. Gas now supplies 27% of the energy needs, and the use may grow at 5% pa. At present there is 5×10^6 bd excess production capacity, *ca* half of it in the U.S.A. U.S. crude producing capacity is $9{\cdot}25 \times 10^6$ bd, and for natural gas liq $1{\cdot}25 \times 10^6$ bd. World production for 1960 was estimated at $18{\cdot}7 \times 10^6$ bd. Well completions in the U.S.A. have fallen from 57,000 in 1956 to *ca* 45,000 in 1960. The return on net assets invested in the domestic producing industry fell from 36% in 1948 to 6% in 1958. Overseas earnings on capital are much higher. A healthy domestic industry requires a return of at least 10%, and not less than two-thirds of the return obtainable abroad.

Max U.S. crude producibility of $9{\cdot}7 \times 10^6$ bd is expected before 1970, and max for natural gas liq of $1{\cdot}4 \times 10^6$ bd a little later. The max total of $11{\cdot}1 \times 10^6$ bd may hold for five years. However, max production may be $10{\cdot}1 \times 10^6$ bd. Texas and Louisiana will provide most of the increased production. Imports may be $4{\cdot}5 \times 10^6$ bd in 1970 and 7×10^6 bd in 1975. G. D. H.

665. Worldwide oil report. Anon. *Oil Gas J.*, 26.12.60, **58** (52), 98–152.—A world survey is given in tabular form of the proved reserves, the number of wells producing and being drilled, daily production, and the number of operating refineries with crude, cracking, and reforming capacity.

The location of oilfields, pipelines, and refineries is shown on a map covering Europe, the Near East, and N Africa, and a country-by-country list is given of the refineries.

A more detailed account of production and refining in each country classified under the broader headings of Europe, Africa, Middle East, Asia–Pacific, and W Hemisphere is presented. A. D. S.

666. Further growth of Italy's ENI. Anon. *Petroleum, Lond.*, 1961, **24**, 17.—The recent activities of the Ente Nazionale Idrocarburi, Italy's state-controlled petroleum industry, are outlined. Exploration and drilling in Italy, Egypt, Somalia, Morocco, Sudan, Libya, and with the YPF in Argentina are mentioned. Expansions in refinery capacity and in petrochemicals are also dealt with. G. D. F.

667. Petrochemical sales in Japan up 5000% in four years. H. S. Pylant. *Oil Gas J.*, 19.12.60, **58** (51), 104–7.—The Japanese petrochemical industry is divided into two distinct divisions—the natural gas chemical industry and the petroleum chemical industry. The present status of the former industry is presented, with details of annual capacity, products produced, and start-up date. The petroleum chemicals industry really started in 1957 with the production of *sec* butanol and methyl ketone, but sales have risen some 5000% since that time. Estimated production figures are given for 1960, and the manufacture of polyethylene, polypropylene, ethylene oxide and ethylene glycol, polystyrene, and aromatics are discussed. A. D. S.

668. European viewpoint on world energy problem. Position of U.S.A. (In French.) G. Tugendhat. *Bull. Ass. franç. Tech. Pétrole*, 1960, 755–62.—Lecture.

MISCELLANEOUS

669. Leaders in oil. 1. Standard Oil Company (New Jersey). T. H. H. Skeet. *Petroleum, Lond.*, 1961, **24**, 5.—A brief review of the early history of the Standard Oil Co (New Jersey) leads up to a statement of this company's position in the world oil picture at present. Tables show production and exploration interests, operating refineries, planned refineries, tanker fleets and tankers under construction, and reserves owned totally or partly by this complicated group of companies. Among other interesting information, it is found, for instance, that the total reserves of "Jersey" probably exceed those of the U.S.S.R. The position with regard to petro-chemicals and the attitude towards research are also outlined. G. D. F.

BOOK REVIEWS

Transport Phenomena. R. B. Bird, W. E. Stewart, and E. N. Lightfoot. New York, London: John Wiley & Sons Inc., 1960. Pp. xxi + 780. 72*s*.

"Transport Phenomena" is the result of an exhaustive review and revision of an earlier volume by the same authors, "Notes on Transport Phenomena," first published in 1958. The subject matter has been designed to cover the whole field of the transfer of momentum, heat, and mass from one system to another, and although it is intended for students of engineering and applied science, it should prove of interest to a much wider readership.

The subject matter has been carefully arranged so that it is possible to study the various phenomena in two distinct ways, either (1) by considering separately the entity (momentum, heat, or mass) transferred, or (2) by considering the way in which transfer occurs as a basically similar problem for each of the three entities. Thus "Transport by molecular motion" is discussed in a group of three chapters, "Viscosity," "Thermal conductivity," and "Diffusivity," and "Transport between two phases" forms the general subject of three chapters on "Interphase momentum transport," "Interphase energy transport," and "Interphase mass transport."

The material is, on the whole, well presented, with numerous worked calculations, and although certain subjects could perhaps have been more completely covered, the book contains a wealth of information, parts of which are suitable for each year of an undergraduate course and other parts of more interest to the post-graduate or research worker. A particularly valuable and welcome feature is the provision of "graded" problems after each chapter and the addition of the numerical answers where necessary.

P. J. K.

Clays and Clay Minerals. Proceedings of the Eighth National Conference on Clays and Clay Minerals, Norman, Oklahoma, October 1959. Ed. Ada Swineford. Oxford, London, New York, Paris: Pergamon Press Ltd. Pp. ix + 292. 63*s*.

Both the presentation and the contents of this admirable volume are well up to the standard which has come to be associated with the Pergamon Press. 22 papers, many of which are of particular relevance to those interested in petroleum, are presented, invariably in a lucid and precise style, and do much to emphasize the close relationship which exists between the two disciplines of clay mineralogy and petroleum technology. The role clays play in the formation of oil is becoming increasingly apparent; the value of quantitative knowledge of their distribution, both as to kind and concentration, steadily assumes greater im-

portance in stratigraphic studies: knowledge of rheological properties and colloid chemistry of clay minerals has revolutionized the technology of oil well drilling fluids: organo-clay complexes have found a place as thickening agents for grease formulation where improved temperature stability is required: the role played by clay minerals in catalytic reactions in refining requires a detailed knowledge of their properties by those interested in such processes.

In this sense the papers presented at the Eighth U.S. National Conference are of particular interest to the oil industry. A particularly stimulating paper by C. E. Weaver demonstrates at least one of the correlations existing between the productivity of oil reservoirs and their expanding clay mineral content, and suggests that free water escaping under high overburden pressure is capable of flushing oil formed in shales into sandstones of higher permeability.

A. F. Frederickson and R. C. Reynolds, Jr, describe a geochemical method for the determination of palaeosalinity in which the boron content of the clay mineral illite is measured and used to estimate, via the known relation between the boron content of sea water and its salinity, the salinity of the water in which illite was laid down in sediments. Other equally stimulating papers concerned with such diverse topics as synthesis of hectorite at atmospheric pressure, the chemical weathering of layer silicate clays, and the geology of selected fireclays are all of interest to the geologist. There can be little doubt that the continued application of established clay mineralogical techniques will contribute substantially to our understanding of the complex phenomena involved in the deposition of sediments.

Papers on the viscosity of water in clay systems, on ion adsorption in clays, and solids concentration effects in bentonite drilling fluids are of equal interest to the physical chemist and the mud engineer. F. Bernstein of the Schlumberger Well Surveying Corpn gives an excellent account of relationships between the electrochemical properties of clays and solutions in equilibria with them, discussing the implications of these properties in the interpretation of electrical surveys.

This volume will certainly find a place in many libraries to form a useful extension to the work reported in previous issues of the same series. G. K. J.

ADDITIONS TO THE LIBRARY

Entries are in subject order arranged according to the Uren " Classification for Petroleum Bibliography," the number preceding each entry indicating the classification and corresponding to that used in the " Library Catalogue " published by the Institute.

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040 NATIONAL ENGINEERING LABORATORY. Heat division. Heat bibliography, 1958. Edinburgh, HMSO, [1960?]. 281 p.

041 SWANSON, E. B., *comp.* A century of oil and gas in books: a descriptive bibliography. New York, Appleton-Century-Crofts, Inc., 1960. 214 p.

050 LEHMANN, G. H. Erdöl-lexikon. Mainz, Heidelberg, Verlagsanstalt Huthig und Dreyer GMBH, 1957. 164 p. (ABC des erdols Band 7.)

056 HUBBELL, A. F. Russian–English scientific and technical dictionaries: a survey. New York, New York University, 1960. 20 p.

080 COUNCIL OF BRITISH MANUFACTURERS OF PETROLEUM EQUIPMENT. Classified list of equipment and services, London, CBMPE, 1959. 112 p.

081 GAS TIMES. Who's who in the gas industry, 1961. Watford, Herts, Gas Publications Ltd, 1961. 204 p.

081 HENRIQUES, Robert. Marcus Samuel, first Viscount Bearsted and founder of the " Shell " Transport and Trading Company, 1853–1927. London, Barrie and Rockliff, 1960. 676 p.

082 OIL AND PETROLEUM YEAR BOOK, 1960. . . . incorporating the Oil and Petroleum Manual, compiled by Walter E. Skinner. London, W. E. Skinner, 1960. 791 p.

094 NORTHERN ALUMINIUM COMPANY LIMITED. Proceedings of the symposium on the use of aluminium in the transport and handling of liquefied gases at sub-zero temperatures, held at Aluminium Laboratories Limited, 12th and 13th April, 1960. Banbury, Northern Aluminium Co., Ltd, 1960. Various paging.

095 INSTITUTE OF PETROLEUM *and* SOCIETY OF CHEMICAL INDUSTRY. Corrosion Group and Chemical Engineering Group. Corrosion problems of the petroleum industry, comprising papers (with discussions) read at a joint symposium . . . held on 26th–27th November, 1959 . . . London, Society of Chemical Industry, 1960. 235 p. S.C.I. Monograph No. 10.

113 CANADA. Department of mines and technical surveys. Mineral resources division. Petroleum refineries in Canada. Ottawa, The Queen's Printer, 1960. 27 p. Operators list 5.

137 FALCON, N. L., *and* KENT, P. E. Geological results of petroleum exploration in Britain 1945–1957. London, Geological Society, 1960. 56 p.

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161 PETROLEUM INFORMATION BUREAU (AUSTRALIA). This age of oil: a history of the petroleum industry in Australia. Melbourne, PIB (Australia), 1960. 204 p.

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234 GRIFFITH, R. H., *and* MARSH, J. D. F. Contact catalysis. London, OUP, 1957. 299 p.

252 INSTITUT FRANCAIS DU PETROLE. Procedure CEC/AT4, European Council for the study of oil test procedures on the Petter AV1 engine. Paris, Société des Editions Technip, 1960. Various paging.

260 AMERICAN SOCIETY FOR TESTING MATERIALS. ASTM Standards on petroleum products and lubricants (with related information). 37th ed. Philadelphia, ASTM, 1960. Vol. 1. Methods of testing, specifications, definitions, charts and tables. 1960. 1130 p.

268 NATIONAL BENZOLE AND ALLIED PRODUCTS ASSOCIATION. Standard specifications for benzole and allied products. 4th ed. London, NBA, 1960. 132 p.

344 UNITED STATES. National Research Council. National Academy of Sciences. Committee on Clay Minerals. Clays and clay minerals, proceedings of the Seventh National Conference on Clays and Clay Minerals . . . held in Washington on October 20–23, 1958; edited by Ada Swineford. London, [etc.], Pergamon Press, 1960. 369 p.

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670 AMERICAN SOCIETY FOR TESTING MATERIALS *and* INSTITUTE OF PETROLEUM. Report on the development, construction, calculation, and preparation of the ASTM–IP petroleum measurement tables (ASTM D1250; IP 200). London, IP; Philadelphia, ASTM, 1960. 36 p.

751 NATIONAL BENZOLE AND ALLIED PRODUCTS ASSOCIATION. Review of benzole technology, 1959. London, NBA, 1960. 151 p.

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841 ASPHALT INSTITUTE. The asphalt handbook. Rev. ed. Maryland, Asphalt Institute, 1960. 398 p.

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OILFIELD EXPLORATION AND EXPLOITATION

GEOLOGY

670. A study of the capillary pressure–hydrodynamic relationship to oil accumulation in stratigraphic traps. B. Habermann. *Canad. Min. Metall. Bull.*, 1960, **53**, 811–17.—Prediction of the accumulation of oil in a stratigraphic trap from a knowledge of the displacement press, the difference in density between the oil and water, and the direction and magnitude of any hydrodynamic gradient is discussed. The theory was compared with results obtained in the Pumkin Creek field, Horn field, and Beall Creek field. In one case the theory was substantiated and, in another, partially so.

G. B.

671. Dolomitization by seepage refluxion. J. E. Adams and M. L. Rhodes. *Bull. Amer. Ass. Petrol. Geol.*, 1960, **44**, 1912–20.—Dolomitization was a normal process in carbonate rocks on barred shelves. The reef barrier prevented free refluxion of waters from the lagoon. Following this restriction of circulation the salinity of the brines increased and evaporites formed. The hypersaline brines eventually became heavy enough to displace the connate waters and seep slowly downward through the slightly permeable carbonates of the lagoon floor. During this seepage, the magnesium replaced part of the calcium and the metastable aragonites and high magnesian calcites recrystallized as dolomites.

E. N. T.

672. Relation of deformational fractures in sedimentary rocks to regional and local structure. J. F. Harris *et al. Bull. Amer. Ass. Petrol. Geol.*, 1960, **44**, 1853–73.—During the course of this study it became apparent that numerous factors govern fracture occurrence and concn. The susceptibility of any stratum to fracturing is dominantly controlled by the thickness and lithologic character of the stratum. These factors are evaluated and used to convert fracture data taken on beds of various lithologic character and thickness to a datum bed. Fracture-pattern and iso-fracture maps are then constructed from these data.

E. N. T.

673. Concepts of foraminiferal palæoecology. O. L. Bandy and R. E. Arnal. *Bull Amer. Ass. Petrol. Geol.*, 1960, **44**, 1921–32.—Many students of modern foraminiferal ecology have investigated quantitative aspects of distribution patterns in recent years. These studies and those of the writers were reviewed and served as the basis for the development of criteria presented and applied in this investigation.

To test the value of this type of research in oil exploration, a detailed study was made of the biofacies of the Middle Tertiary of the San Joaquin Basin, California. The analysis of more than 5000 core samples from selected wells made it possible to construct a series of environmental maps showing the gradual evolution of the San Joaquin Basin during the Middle Tertiary. Selected samples from that project are

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presented here to illustrate the methods of palæoenvironment analyses. E. N. T.

674. 1960 oil hunting good in spots. Anon. *Oil Gas J.*, 30.1.61, **59** (5), 145–53.—The Lisbon field, Utah, was one of the major discoveries of the Rocky Mountain region in 1960. Devonian production there tapped a new horizon for the Paradox Basin. The field is on the southernmost of five major salt anticlines SW of the Uncompahgre uplift. The discovery well flowed 587 bd from the Devonian at 8261–8348 ft, and 17·5 MM cu ft/day gas from the Mississippian; later wells found oil in the Mississippian. In the N Rockies interest centred on the Green River, Wind River, and Powder River Basins and the Williston Basin. In the latter, there was a significant Devonian discovery at the Tule Creek field, NE Montana, which flowed 476 bd from the Nisku formation at 7660–7666 and 7689–7692 ft. Two discoveries at great depth were made in the W Texas sector of the Delaware Basin, with gas and condensate from the Pennsylvanian in one at below 15,000 ft, and gas from the Ordovician in the other at 16,680 ft. In SE New Mexico the Abo reef trend attracted attention; reserves range up to 25,000 brl/acre. Mississippian and Pennsylvanian formations are found to be productive with modern completion methods in the long-overlooked Kingfisher County area, Oklahoma. In S Texas a chain of new fields has been discovered on the deep Edwards Lower Cretaceous trend, with oil at Fashing, Big John, Panna Maria, Persons, and in Gonzales County, and gas condensate at Word, bringing the total of fields to 23. Seven new gas fields and one new oilfield were discovered in the Jurassic of E Texas. In Alaska the Soldotna discovery was the best find to date, with 1870 bd from the Eocene Hemlock sand at 10,228–10,585 ft; the Swanson River field grew into a major reserve during the year. J. C. M. T.

675. Pennsylvania gas hunters look toward the east. F. J. Gardner. *Oil Gas J.*, 20.2.61, **59** (8), 193.—There is renewed exploration in Pennsylvania where gas is the main target, and a recent discovery of Devonian Oriskany pay in Blair County is reported. The well produced 1200 Mcfd from 6858 ft, and the new field is 22 miles from the nearest production; it is the most E Pennsylvanian field. It is situated in the en echelon fold belt and is only three miles NW of the Oriskany outcrop. C. A. F.

676. Pre-Cambrian rocks at North Franklin Mountain, Texas. R. L. Harbour. *Bull. Amer. Ass. Petrol. Geol.*, 1960, **44**, 1785–92.—Structurally, the Franklin Mountains consist of a linear block of faulted bedrock tilted W and presenting a steep frontal scarp to the Hueco bolson on the E. Within the mountains, more than 10,000 ft of sedimentary rocks ranging in age from pre-Cambrian to Cretaceous dip steeply westward.

In ascending order the pre-Cambrian rocks consist of the Castner limestone (new name), the Mundy breccia (new name), the Lanoria quartzite, and an unnamed rhyolite unit. The Castner limestone may be equivalent to the Allamore limestone of the Van Horn area, 100 miles to the E. However, other pre-Cambrian formations in the two areas are so unlike that positive correlation cannot be made. E. N. T.

677. Marietta Basin dazzles gas hunters. R. J. Enright. *Oil Gas J.*, 6.2.61, **59** (6), 82–4.—The Marietta Basin is a relatively small deep syncline in Grayson and Cooke Counties, N Texas, and Love County, Oklahoma. It is bounded on the W and SW by the buried Muenster arch and the Sandusky platform, on the N by the Criner Hills trend and Ardmore Basin, and on the E by the Ouachita trend. The area is complicated by thrusting. Heaving shales are encountered. Gas-condensate has been struck in the Ordovician Oil Creek formation in two areas, SE Marietta and New Mag, in the E and W of the basin respectively. SE Marietta now has nine wells averaging *ca* 50,000,000 cu ft/day gas with high condensate yield from a depth of *ca* 14,000 ft. New Mag has six producing wells, producing in the range 50–80 MM cu ft/day and a higher condensate yield than SE Marietta. J. C. M. T.

678. Swisher Gabbroic Terrane of Texas Panhandle. R. Roth. *Bull. Amer. Ass. Petrol. Geol.*, 1960, **44**, 1775–84.—The Palæozoic sediments of the Panhandle of Texas and NE New Mexico rest on a complex sequence of igneous and metamorphic rocks, the age of which is considered to be mainly pre-Cambrian. The S part of this area, which has been named the Swisher Gabbroic Terrane, is underlain by diabase and related igneous rocks.

Two wells recently drilled in the Plainview Basin have added new information to the age concept of the basement. A re-examination of all the wells drilled in the Swisher Gabbroic Terrane indicated that much of the Gabbro is a diabase. E. N. T.

679. Petroleum in Comanche (Cretaceous) section, Bend area, Florida. J. E. Banks. *Bull. Amer. Ass. Petrol. Geol.*, 1960, **44**, 1737–48.—The purpose of this study is to describe and discuss 430 ft of sub-surface strata associated with the Sunniland pay zone in the Bend area of S Florida, in which commercial amounts of oil have been found. The scope is limited to a study of lithologic features and occurrences of hydrocarbons, and oil-trapping conditions are discussed.

In the Bend area depositional structures plunge very gently NW and are tilted NE, which is the reverse of regional dip. E. N. T.

680. Tyler sand trend becoming better known in Dakotas. F. W. Foster. *World Oil*, Jan 1961, **152** (1), 89.—Tyler sands in the basal Pennsylvanian of SW N Dakota and Central Montana in the Williston Basin are proving to be important reservoir rocks. They form stratigraphic traps in sand lenses which overlie unconformably Upper Mississippian formations. Basal Tyler cores show sand–shale conglomerates with fragments of probably Otter shales and other Mississippian rocks. Locally Tyler sands reach 300 ft thick, and regional studies show that they were probably deposited on a flat shelf in N Dakota and in a basin area in S Dakota. Good oil staining has been found in cores in the S Nesson anticline and associated shales seem to be good potential source rocks. Regional history of the Williston Basin is outlined and the geology of the Tyler is described in detail with maps and cross-sections. C. A. F.

681. Shallow drilling, large blocks prompt operators to check Chama Basin. K. Chasteen. *Oil Gas J.*, 16.1.61, **59** (3), 122.—There is renewed interest in the oil possibilities of the Chama Basin in Rio Arriba County, New Mexico, and Archuleta County, Colorado. There are possibilities for shallow production following the discovery of 500 Mcf to over 1 MMcfd of gas in Gt American 1 Sargent, which found Jurassic Morrison pay at 900–950 ft. The well was sited following surface geology and mapping and magnetometer surveys. The area is of high elevation, the well being sited at 7929 ft above sea level. Exploration in the area has been retarded by the control by one estate of a very large segment of the area, and by rugged terrain, bad weather, and unco-operative practices.

The geology of the basin is outlined: it merges NW into the San Juan Basin of Colorado and is filled with late Palæozoic and Mesozoic beds with Tertiary and Quaternary at surface. There are many short faults and several major faults. Oil shows have been reported from shallow depths in wells, but drilling has been sparse. C. A. F.

682. Probable Triassic rocks along eastern front of Sangre de Cristo Mountains, South Central Colorado. R. B. Johnson and E. H. Baltz. *Bull. Amer. Ass. Petrol. Geol.*, 1960, **44**, 1895–902.—Until recently, beds of Triassic age were believed to be absent in the Sangre de Cristo Mountains in S-Central Colorado. However, two units of probable Triassic age have been separated from the top of the Sangre de Cristo formation. The younger of these units is here named the Johnson Gap formation, and is correlated with beds of grey limestone-pebble conglomerate in the Dockum group of Triassic age in N New Mexico. The older unit is referred to as the Lykins (?) formation and is correlated with the Lykins formation of Permian (?) and Triassic (?) age in Central Colorado.

The Johnson Gap formation and the Lykins (?) formation differ lithologically and probably are not correlative. The latter is probably older than the Johnson Gap formation in that it seems to grade into the underlying Sangre de Cristo formation, whereas the Johnson Gap formation overlies the Sangre de Cristo unconformably. E. N. T.

683. Rocks of Mississippian and probable Devonian age in Sangre de Cristo Mountains, New Mexico. E. H. Baltz and C. B. Read. *Bull. Amer. Ass. Petrol. Geol.*, 1960, **44**, 1749–74.—In these mountainous regions of N New Mexico, pre-Cambrian crystalline rocks are overlain by a thin but complex sequence of limestone and sandstone of pre-Pennsylvanian age. These rocks, formerly classed variously as the lower limestone member of the Sandia formation, and the Arroyo Penasco formation, are here divided into two new formations on lithologic bases.

The lower formation, which consists of sandstone, sandy dolomitic limestone, and crystalline and clastic limestone, is here named the Espiritu Santo formation. Overlying the Espiritu Santo formation is a sequence of limestone breccia and conglomerate, crystalline limestone, and calcarenite, here named the Tererro formation and which has been divided into three members. In ascending order these are the Macho, Manuelitas, and Cowles members. The Espiritu Santo formation ranges in thickness from a trace to more than 80 ft, with an irregular but general increase in thickness from S to N. The Tererro formation ranges in thickness from a trace to 130 ft in the S and from 6 to 48 ft farther N. E. N. T.

684. Recent domal structures in SE New Mexico. J. D. Vine. *Bull. Amer. Ass. Petrol. Geol.*, 1960, **44**, 1903–11.—The domal structures described herein lie within or marginal to the Delaware Basin and are characterized by brecciated cores of stratigraphically displaced rock and by the deformation of rocks apparently including those as young as the Recent caliche.

The stratigraphic sequence of the region is characterized by as much as several thousand ft of saline rocks, chiefly halite and anhydrite belonging to the Castile, Salado, and Rustler formations (from oldest to youngest) of late Permian age overlain by a few hundred ft of red siltstone and sandstone belonging to the Pierce Canyon redbeds of Permian or Triassic age and the Santa Rosa sandstone of Triassic age. E. N. T.

685. Four Corners keeps lead in production of helium gas. J. W. Dean and R. E. Lauth. *Oil Gas J.*, 20.2.61, **59** (8), 194.—Significant accumulations of helium have been known in the Four Corners region of the Rocky Mountain area for many years, and the best known fields are Rattlesnake, Hogback (New Mexico), Model (Colorado), Henley (Utah), and Pinta (Arizona). Until recently Pinta had the richest known accumulation, with 8–9% helium. In 1960 additional discoveries were made in the Navajo–Chambers area, the Salt Springs structure, for example, was found to contain *ca* 10% helium bearing gas. The geology of these fields is outlined; the area is on the Mogollon slope bordering the Black Mesa Basin, and the Navajo Springs structure forms the SE limb of a major NW–SE trend to the Pinta culmination. Reservoir data are included. Six refs. C. A. F.

686. Geologists appraise Tule Creek area. J. C. Kinard. *Oil Gas J.*, 6.2.61, **59** (6), 172.—The discovery of oil in Devonian Nisku in Oct 1960 at Tule Creek in Roosevelt County, Montana, is of special interest because the area is remote and the pay has not hitherto been found in Montana, although many shows have been reported in the past. The discovery wells were drilled along the Poplar anticline, which projects SE off the Bowdoin dome and forms a subsidiary feature on the W flank of the Williston Basin. Beds exposed range from Tertiary to Upper Cretaceous, and to the W gas has been found in Cretaceous Colorado sands in the Bowdoin field. At depth beds range from Lower Cretaceous down to pre-Devonian, and there are prospects in the Cretaceous Judith River and in many Palaeozoic formations. Potential traps in the area are mainly stratigraphic due to Pennsylvanian up-dip sand pinch outs (Tyler) and in zones of secondary carbonate porosity along unconformities. The trend of the Popular anticline is *ca* 65 miles long and 20 miles wide and is a feature of the Laramide orogeny. Drilling has so far been mainly in the E Poplar field area, where there is excellent Charles production. The area is, however, mainly untested, and there are some good prospects. C. A. F.

687. Wildcat efforts fail to hit pay dirt in Badger State. F. J. Gardner. *Oil Gas J.*, 30.1.61, **59** (5), 221.—Following gravity surveys of the W shore of Lake Michigan, a series of stratigraphic tests was put down to determine possible trapping conditions. All were unsuccessful, but there may be further drilling in the area. An early well in 1949 was also unsuccessful, and the region is not generally thought to have good prospects. Suitable structures for underground storage may, however, exist. Glacial drift is overlain by Silurian Niagara dolomite *ca* 600 ft thick. This is underlain by Maquoketa dolomitic shale which could be a trap barrier. C. A. F.

688. Rocky Mountain Four Basin report. Pt 2. Anon. *World Oil*, Jan 1961, **152** (1), 101.—Oilfield development in the Wind River and Big Horn Basins are discussed. In the Wind River Basin Beaver Creek has become one of the most important fields in Wyoming. It contains six pays, three of which are oil (Second Cody sandstone, Tensleep sandstone, and Madison dolomite). Water flooding has been introduced. Other notable fields briefly discussed are Circle Ridge and SE Sheldon. Formations in the basin range from Palaeozoic to Tertiary, and possible traps in the Lander region include stratigraphic (on SW flank of the basin), pre-Tertiary anticlines, and fault closures on plunging noses.

The largest field in the Big Horn Basin is Elk Basin, yielding *ca* 60,000 bd. It is one of the top ten fields of the U.S.A. and produces from three pays, mainly from Embar–Tensleep. Pressure maintenance is being carried out. Other important fields briefly described include Grass Creek, Byron, Oregon Basin, and Garland. Grass Creek occurs along the crest of a major fold on the SW rim of the basin and shows marked surface structure. There are over 2000 ft of closure and the water table is tilted. Production comes from the Frontier (discovered 1914), Curtis, Embar–Tensleep, and Devonian and Madison (discovered 1958). Secondary recovery is being operated. C. A. F.

689. Washington driller aims to hit oil pay. R. J. Deacon. *Oil Gas J.*, 6.2.61, **59** (6), 182.—Several anticlines are known in the Puget Sound area of Washington State, and many unsuccessful wells have been drilled. Recently the Kummer

anticline near Buckley has been tested and wells found highly porous and permeable sands with partial oil staining, but commercial production has not yet been established. Subsurface geology is complex and there is much faulting, which should provide closure on the NE flank of the anticline. A new well is being drilled in the area, and if successful would be a new state discovery. All attempts to develop commercial production in Washington have so far been unsuccessful, the main area of interest being Puget Sound, where there is an Eocene basin filled with a thick section of mainly non-marine sandstones, shales, and coals. Gas shows in shallow wells have, however, been known for many years. C. A. F.

690. Alberta gets best discovery in several years. F. J. Gardner. *Oil Gas J.*, 13.2.61, **59** (7), 123.—The Buffalo Lake wildcat, *ca* 1¾ miles NW of the Erskine field between Edmonton and Calgary, has been completed for 323 bd from Devonian limestone at 5607 ft. It discovered a new reef, the top of which is 60 ft lower than the oil–water contact at Erskine, and it is the first new reef find in S–Central Alberta for several years. New seismic search in the area is now expected. The new well has also found the thickest reef pay yet discovered in this region, but not as thick as Golden Spike, where 620 ft has been recorded. C. A. F.

691. Sulphur isotope fractionation in early diagenesis of recent sediments of NE Venezuela. H. G. Thode *et al. Bull. Amer. Ass. Petrol. Geol.*, 1960, **44**, 1809–17.—Recently studies have been made of the hydrocarbon content of recent ocean sediments in the hope that the results might give information on the origin of petroleum. This study deals with sediments from the Pedernales field of NE Venezuela at depths of 20, 80, and 160 ft. Data are presented for these ratios for sulphate sulphur, elemental sulphur, pyrite sulphur, organic sulphur, and those sulphides soluble in hydrochloric acid. The results indicate that bacterial reduction of the marine sulphate is almost complete at depths of 12–20 ft and that sulphates found at greater depths are probably formed by oxidn of pyrite *in situ* without any further isotope fractionation. E. N. T.

692. Jamaica exploration to be unhurried, thorough. G. R. Wood. *Oil Gas J.*, 30.1.60, **59** (5), 222.—Unstable political conditions in Central America have encouraged exploration in areas with stable governments, as in Jamaica. The island has had an active geological survey since 1949, and useful stratigraphic data have become available during the last ten years. Until recently oil prospects were considered poor because of supposedly thin Tertiary and Cretaceous rocks, largely volcanic. In spite of four dry wells in the SW, it is now thought that there are possibilities, especially in the N coastal zone and the E part of the island, where thick Cretaceous rocks are known and there is a gas seep. Details of the stratigraphy and structure of Jamaica are given. Middle and Lower Tertiary rocks cover most of the island, with prominent limestones showing karst topography in places, which causes unreliable seismic data. Cretaceous carbonaceous shales are also known. Much of the island had not been explored geologically until quite recently, due to inaccessibility and heavy rain-forest jungle. More field and micropalæontological work remain to be done, and should provide valuable data for further oil exploration. C. A. F.

693. Know your basement in North Africa. Anon. *World Oil*, Jan 1961, **152** (1), 73.—A knowledge of the basement rocks in N Africa is invaluable to successful exploration. These rocks range from granite or gneiss to unmetamorphosed sediments in various areas, and they have a strong influence on magnetic and refraction data. Apart from the Sirte Basin in Libya, most of the best prospects are in Palæozoic rocks close to the basement: in the Hassi Messaoud and Hassi R'Mel fields of the Sahara, for example, structures are probably influenced by basement forms. The geology of Libya is outlined: in W Libya there are two distinct basins, the Gandames on the NW and the Mourzouk in the SW, both containing Palæozoic sediments. There is a N–S Silurian trend dividing the Mourzouk Basin from the Koufra Palæozoic Basin to the E. In E Libya the main area of interest is the Sirte Basin in the NE. This contains Cretaceous–Palæocene rocks which are productive. The distribution of pre-Cambrian outcrops in Morocco, Mauretania, Sahara, and Libya is discussed and a tentative correlation chart of the pre-Cambrian is presented. 19 refs. C. A. F.

694. Lower Palæozoic prospects enhanced in Sahara area. Anon. *World Oil*, Jan 1961, **152** (1), 71.—There is active development of a new field in the Algerian Sahara at Hassi El Gassi–Erg El Agreb. Pays are Cambro-Ordovician sandstones and existing pipeline facilities from Hassi Messaoud to the Mediterranean coast are to be extended by a 10-inch spur line to the new field. It is hoped that 10,000 bd of Hassi El Gassi oil will be moved by May 1961.

Cambro-Ordovician production was first found in the area in 1956 when Hassi Messaoud was found in the Oued Mya concession. Oil is 43°, sulphur-free, and occurs at *ca* 10,000–11,000 ft. Development has shown that the productive area of the field exceeds 500 sq miles with 20 billion brl estimated oil in place. Recoverable proportion will probably be low and conservative estimated recoverable oil is 1¼ billion brl. Details of later discoveries are given and a map shows main structural features of N Africa. C. A. F.

695. Stratigraphy of the Upper Hauterive in petroleum field Georgsdorf (Emsland). (In German.) B. Zedler. *Erdöl u. Kohle*, 1959, **12**, 879–83.—Georgsdorf oilfield discovery in 1943 in Emsland has assumed importance for micropalæontological classification of NW German Lower Cretaceous. First, extensive core material with very rich microforaminifera and ostracods is available from drillings in this field. Secondly, many discoveries of cephalopods and lamellibranchiata have become known and, finally, classified diagrams of elec borehole measurements make possible detailed stratigraphic comparisons within the field. Intensive stratigraphic, tectonic, and oil–geological relationships of the Georgsdorf structure investigated by various authors are quoted. The rich foraminifera–fauna have been evaluated only partly. Range and frequency distribution of 20 stratigraphically important and characteristic foraminifera types of the Upper Hauterive are discussed with the purpose of classification according to ammonite zones. 12 refs. R. T.

696. Transformation of organic matter in bituminous shales by metamorphism: the Posidonomia shales of the Toarcian of Lower Saxony. (In French.) M. Teichmuller *et al. Rev. Inst. franç. Pétrole*, 1960, **15**, 1567–74.—It has proved possible to determine the degree of coalification by optical means even when a rock contains only small particles of organic matter. Work on the Wealden, younger, and older rocks in the Lower Saxony Basin has shown, in accordance with D. White's carbon ratio theory, a close agreement between the degree of metamorphism of the organic matter and the presence or absence of oil. The reflecting power of the organic matter of the Posidonomia shales has been found to vary from point to point, and the organic matter from a series of points has also been studied by means of its oxidn characteristics. Corrections of the results for the presence of pyrites has been made. Reflectivity measurements on thin sections group the samples in a manner similar to the oxidn work, but without the finer distinctions. Selective oxidn curves show a decline for rocks which have not provided oil, and a rise for those which have

given oil. The known oil and gas fields show a distribution in the Lower Saxony Basin which is linked with the degree of metamorphism of organic matter in the Mesozoic rocks; they are in the zones of least metamorphism. G. D. H.

697. Oil basins surround the Arctic Ocean. L. Smirnow. *World Oil*, 1.2.61, **152** (2), 27.—In spite of the crude oil surplus, there is active interest in the oil prospects of the Arctic. Already commercial production has started in Alaska, there are possibilities of leasing in the Canadian Arctic islands, and oil geological mapping was carried out in Spitzbergen in 1960. Experience gained in world war II has enabled oil operations to be adapted to cold climates, but permafrost at depth is a problem in geophysical work and in production operations. The broad geology of the Arctic region is described. The polar area represents an ancient platform, and recent soundings show that there is a ridge below the ice cap which is parallel to the European continental slope from the New Siberian Islands to Ellesmere Land; this may be an old mobile belt. There are three platforms adjacent to the Arctic mass: the Canadian–Greenland shield, the Russian–Siberian platform, and possibly a Scandic platform. Large prospective sedimentary basins cover parts of these with Palæozoic and Mesozoic sediments. Within the mobile belts are important median masses, such as the Cook Inlet and Spitzbergen masses. Potential Arctic oil basins are listed, and the structure of the N Canadian islands and Greenland are outlined. Detailed radial cross-sections across the Arctic are included. Six refs. C. A. F.

GEOPHYSICS AND GEOCHEMICAL PROSPECTING

698. Radiation surveys can find oil. G. A. Miller. *Oil Gas J.*, 13.2.61, **59** (7), 127.—It is claimed that surface radiation surveys are an economical and effective means of locating oilfields from the surface. The basic theory of the method is simple; it is based on the fact that gas leakages are greater over known oil accumulations than over barren areas. This can be determined by geochemical analyses, and it is suggested that, in the same zone of gas escape, there is also excess of water evaporation which leads to deposition of minerals in the form of a halo. It is this halo which is detected by radiation surveys which use ionization chambers coupled to continuous strip chart recorders. Considerable experience of these surveys in S Texas, N and Central Texas, N and S Louisiana, and Mississippi has shown that they can outline producing areas. Costs range from $5 to 10/mile of profile. Examples of radiation surveys are described, and it is recommended that the method be used for reconnaissance and supplemented where possible with conventional tools. Two refs.

C. A. F.

699. Reliability of glauconite for age measurement by K–Ar and Rb–Sr methods. P. M. Hurley *et al.* *Bull. Amer. Ass. Petrol. Geol.*, 1960, **44**, 1793–808.—In this study an attempt has been made to discover if the mineral glauconite can be used for the measurement of the absolute age of sediments. The results appear to fall 10–20% short of ages measured on micas associated with dated igneous rocks. K–Ar and Rb–Sr age values are closely concordant in the majority of samples. In no samples measured by the writers have glauconites yielded ages that are definitely higher than expected limits in the time scale.

Glauconites form a range of material in which there is an increasing amount of expandable layers. The purest glauconite has *ca* 10% or less of expandable layers. The potassium content of glauconites is inversely proportional to the percentage of expandable layers. The percentage of expandable layers is greater in younger glauconites than in older.

The writers conclude that glauconite may have a limited use in the dating of unknown sediments because of the consistency indicated in world-wide comparisons, on an empirical glauconite age-scale. E. N. T.

700. Reflection–seismic picture of Bentheim sandstone in Meppen space. (In German.) K.-H. Seelis. *Erdöl u. Kohle*, 1959, **12**, 953–7.—Reflection–seismic measurements carried out in concession region Hebelmeer to clarify the behaviour of Bentheim sandstone—producing in some wells—are discussed. The object is to follow from S, from Bentheim sandstone over disturbance systems away, on the basis of the reflection character, and to determine its pinching out region in N. Through irregular charging distribution in reflection surface shots the disturbance level in seismograms Hebelmeer 1958 could be lessened considerably, so that the elec filter of the apparatus could be opened widely, especially to high frequencies. In this way registered seismograms produced preponderantly very clear reflections with many types of oscillatory details, making good character correlations possible. The negative velocity, especially at the base of the Bentheim sandstone, and the neg reflection resulting therefrom can be used for identifying this reflection horizon and for information on the pinching out of the Bentheim sandstone. Six refs.

R. T.

701. Circular slide rule for the seismic function $V = V_o + at$. (In English and French.) P. Bois and A. Oudelette. *Rev. Inst. franç. Pétrole*, 1960, **15**, 1547–66.—On one side of the slide rule the dip may be calculated as a function of the time gradient, two-way reflection time, velocity at the datum plane, and the acceleration; on the other side the depth and offset of the reflector can be obtained as a function of the time gradient, acceleration, and the dip angles computed on the first side. The relevant formulæ are derived. The inner disk on one side has a family of curves representing $\alpha_o = \sin^{-1} pV_o$ and a scale for the acceleration a; the outer disk has scales for the two-way time T; the middle disk has the time gradient $p = \frac{\Delta T}{\Delta X}$ and the dip α. The inner disk on the other side has families of curves for $\sin(2\alpha_o + \alpha_1) \sin \alpha_1$ for depth computation, and $\alpha_1 - \cos(2\alpha_o + \alpha_1) \sin \alpha_1$ for the offset; the scale for the acceleration is on the outer disk, that of $\frac{\Delta T}{\Delta X}$ on the inner disk; a transparent disk with the scale for depth and offset can be fixed to the inner disk in two positions.

Examples of the use of the slide rule are given.

G. D. H.

702. Refraction seismic surveys in the Sahara. L. Migaux. *Rev. Inst. franç. Pétrole*, 1960, **15**, 1371–83.—Seismic refraction surveys led to the discovery of Hassi-Messaoud, El Gassi, and Hassi R'Mel, the three main oil and gas fields of N Sahara. Hassi-Messaoud, found in 1956, now has over 40 wells in an area of 1000 km². The accumulation is in beds below a post-Cretaceous unconformity at *ca* 200 m, and a post-Palæozoic unconformity at 3200 m. The Tertiary and Mesozoic beds are almost horizontal. The Lias and Trias have 1000 m of salt, anhydrite, and clay.

The Cambrian sandstone reservoir rock underlies the Trias, and has Ordovician and Gothlandian rocks on its flanks; underneath is granite and in the N pre-Cambrian sediments. The 600 m of Cambrian sandstones diminishes in permeability downwards, the reservoirs being in the upper 100–150 m. A drop of 900 m occurs in 76 km in the W; the southerly drop may be *ca* 400 m for the basement. It appears that neither magnetic nor gravimetric studies would have shown the structure clearly; electrical surveys would have encountered difficulties. Deep reflections would be difficult to obtain and detect through the thick Mesozoic with its strong reflectors.

New developments have afforded possibilities, but at the start of the exploratory work (1948) seismic refraction held out most hope. Marine Mesozoic outcropped in the N, then flat-lying Tertiary and Quaternary with thin continental Mesozoic farther S. After shooting along the Ghardaia–Berriane line, a well was drilled at Berriane in 1952–53 to check on the high-velocity medium, and this showed good reservoir rocks in the basal Trias, with less good reservoirs in the Palæozoic; indications of hydrocarbons were found. The Trias sandstones were clearly closed, and the Palæozoic could be a trap where the structure was favourable. Refraction showed the main features of the basement. Wells were drilled on the Hassi R'Mel and Hassi-Messaoud features, the former finding gas and the latter oil. Drilling showed good agreement with the Hassi-Messaoud refraction picture, and the reflection map for the Aptian showed minor highs. At Hassi R'Mel the deep and shallow pictures differed in form. Nearly 9000 km of refraction profiles have been shot for *ca* 500,000 F/km, a cost comparable with that for reflection shooting. G. D. H.

703. How the Sahara's geophysical problems are being resolved. Anon. *World Oil*, Jan 1961, **152** (1), 76.—Geophysical work in N Africa has been hampered by the remote nature of the terrain and also by the difficult surface and weathered zone conditions due to sand dunes and to highly variable characteristics of the basement. Main area for geophysical surveys is the Trias Basin of Algeria. Problems in gravity, electrical, and seismic surveys are outlined. The weight dropping technique has been used successfully in Algeria and Libya.
C. A. F.

DRILLING

704. What's new in the drilling industry. J. F. Earl. *World Oil*, 15.2.61, **152** (3), 63.—Several new types of equipment and improved practices are the main features of development drilling in 1960. Aerated sea water has been used successfully off the Florida coast as a drilling medium where local conditions favoured its use for economy, but it has serious limitations for general use, *e.g.* horizons having greater than normal formation pressures cannot be effectively drilled. Air/gas drilling has also continued, with consequent improvements in drilling penetration rates. Foaming agents have been introduced and are now used in 60–70% of air-drilled wells. High density muds have been used at Agha Jari in Persia and to handle severe lost circulation, extensive high pressure water flows, and salt beds. Clay-free salt water muds are being introduced for drilling shallow wells penetrating salt; this type of mud has solids of only 2% compared to the usual 6–12% and is cheaper and gives higher penetration rates than conventional muds; it is not suitable for deep wells. New rig features which are described include reduced substructure height, new portable drilling rig, and rotary rig drive. Hydraulic wall-anchored drill collars and a new aluminium drill pipe have been developed. Improved drilling practices are noted. 11 refs. C. A. F.

705. Total completions in 1960 plummet to 46,751, down 5013 for the year. Anon. *Oil Gas J.*, 30.1.61, **59** (5), 108–17.—Total well completions in the U.S.A. in 1960 fell to 46,751 from 51,764 in 1959. The only states not sharing this trend were Kansas and California. Of 9635 wildcats drilled (as against 10,073 in 1959), 853 found new oil pools, 112 were condensate strikes, 336 gas field discoveries, and 8334 failures. Average depth was 4601 ft. The most important discoveries were made in the Rocky Mountains, Texas, Oklahoma, the Williston Basin, and Nebraska. In Texas the state's deepest production was established in Pecos County below 16,680 ft in the Ordovician. Drilling statistics are listed, by states.
J. C. M. T.

706. 2000 more cable-tool wells drilled last year than in '59. Anon. *Oil Gas J.*, 30.1.61, **59** (5), 118.—A rise in cable-tool drilling in 1960 in the U.S.A. was due mainly to activity in the stripper areas of E Kansas and NE Oklahoma. There were 12,000 shallow completions. J. C. M. T.

707. Rotary-rig activity averaged only 1915. Anon. *Oil Gas J.*, 30.1.61, **59** (5), 119.—The highest number of rigs drilling simultaneously during 1960 in the U.S.A. and Canada was 2077, in the first week. The year's average was 1915, the lowest since 1947, and compares with 2245 in 1959.
J. C. M. T.

708. Evaluation of hydrocarbon reservoirs by means of logging. (In French.) A. Poupon. *Rev. Inst. franç. Pétrole*, 1960, **15**, 1636–40.—Porosities may be determined under favourable conditions by the use of the microlog, microlaterolog, neutron retardation, or by sonic logs. Often the salinity of the interstitial water can be obtained from the SP log. The true resistivity, which is required for deducing the hydrocarbon saturation, may be obtained for thick beds by conventional normal and lateral logs, or by focused and induction logs for thinner beds even with relatively deep invasion. Porosity and saturation measurements are difficult in clayey formations. SP curves can indicate permeable zones, as can the microlog–microdia devices, but the distinction is qualitative, probably showing whether the value is above or below *ca* 1 mD.

Correlation and dip measurements can be made.

The determination of the true resistivity is difficult with deep invasion; porosity measurements by neutron methods fall in accuracy in large dia holes. Direct measurements on cores and fluids can provide coeff and exponents for use in empirical formulæ for interpreting logs. For good results the combination of logs must be selected to suit the well conditions. The ability to distinguish between hydrogen and chlorine by the γ-ray energies may permit the detection of an oil/water contact in a cased hole. G. D. H.

709. How to reduce casing and tubing load on surface string. J. S. Spencer. *Oil Gas J.*, 6.2.61, **59** (6), 136–8.—The trend towards heavier casing and tubing strings brought about by deeper wells and the " full tension " method of casing landing has increased the loads on surface pipe, with risk of buckling or thread failure unless excessively heavy and expensive surface casing is used. To avoid this, if the surface casing cement job is sound and the surface formation strong enough, the surface casing can be welded instead of threaded to the well-head. Alternatively, with surface formations of adequate load-bearing capacity, a concrete pad can support part of the suspended load via a landing base. J. C. M. T.

710. What new standards for 4½-inch API casing will mean to users. J. A. Casner. *Oil Gas J.*, 16.1.61, **59** (3), 97–8.—The API pipe-standardization cttee has set up new standards for 4½-inch casing. Choice of wall thickness has been added to by a new standard 0·224-inch, and thread length has been increased to 2⅜ inches except on the lightest pipe. These changes will permit the use of casing strings better matched to strength requirements, and these will be more economical. Also, excessive use of cross-over joints will be avoided.
J. C. M. T.

711. Electric log interpretation in exploring for stratigraphic traps in shaly sands. H. A. Slack and C. Otte. *Bull. Amer. Ass. Petrol. Geol.*, 1960, **44**, 1874–94.—Stratigraphic traps are formed by lateral changes in porosity and permeability. These changes are usually associated with changes in rock texture and occur in carbonate rocks as well as in sandstones and shales. This study was undertaken to determine whether the techniques of quantitative interpretation of conventional electric logs could lead to the development of

other mappable attributes to aid in the exploration for stratigraphic traps. Two quantities which provide useful and reliable information can be calculated in this way: (1) shaliness, and (2) saturation ratio.

The values of shaliness and saturation ratio when viewed together are related to the performance of the formation under production tests. A single favourability criterion is developed which is a joint function of shaliness and saturation ratio. This criterion, based on electric log-derived quantities, is a numerical estimate of the production performance of a formation; its use in exploration is demonstrated by maps of its variation in shaly sand reservoirs of several oilfields.

E. N. T.

712. Discussion of efforts to develop improved oilwell drilling methods (by L. W. Ledgerwood). J. Raynal. *J. Petrol. Tech.*, Dec 1960, **12** (12), 63–7.—Some details are given of Russian developments. The rotary vibrator has oscillations of 50/sec of amplitude $\frac{5}{64}$ inch. In lab tests on granite, $5\frac{1}{4}$-inch bits penetrated twice as fast as conventional bits.

Rock destruction by high-tension electrical discharge raises problems in constructing small dia high-capacity condensers. In explosive drilling, charges in plastic containers are introduced into the mud at 7–12/min. The charge is primed by passage though a choke which must be kept 1 ft off bottom. Explosion occurs on striking bottom. Penetrations of 10 ft/hr have been obtained at 6500 ft in hard rock. The cost is high, well dia is irregular, and plastic rocks cannot be handled effectively.

The turbo-drill may compete with rotary at 7000–8000 ft; over 10,000 ft poor mud and small footage per bit are a handicap. Electro-drilling is on a semi-industrial scale, and a subject of debate. Hydro-drilling can do 20 ft/trip instead of 4–5 ft for conventional cable tool. The experiments with a retractable bit for turbo-drilling have been abandoned. There is much work on automation. Persistence is necessary to find whether new methods can compete economically.

G. D. H.

713. Oil stands to gain from the Mohole. F. J. Gardner. *Oil Gas J.*, 16.1.61, **59** (3), 119.—The proposal to drill to the Moho layer (the Mohole project) is viewed with mixed feelings by oil geologists. It is thought by some to be wasteful in time and money, but others consider that useful data will be obtained on drilling techniques and physical properties of beds at depth. The first test drilling is to be carried out E of Guadalupe Islands in the Pacific Ocean W of Mexico. A drilling ship will be used unmoored in *ca* 12,000 ft of water. The aim of this test is to study drilling methods in very deep water: offshore drilling has so far been confined to not more than 1500 ft of water. The final hole will be drilled where the earth's crust is believed to be thinnest. C. A. F.

714. How different mud additives affect *Rm–Rmf–Rmc* ratios. H. M. Johnson. *World Oil*, 1.2.61, **152** (2), 49.—The complexity of modern muds developed to combat the high temp and pressures of deeper drilling has introduced new problems in formation evaluation. The main measurement is *Rm*, for which a NaCl chart is often used, but this can involve errors in complex muds, *e.g.* in oil-emulsion and gypsum base muds the chart is satisfactory for some but not all, so a series of lab experiments was carried out to determine variations of mud resistivity with temp when the effect of one additive at a time could be considered on a standardized gel mud. A diagram is presented which shows that the results of the tests indicated that exact values may vary by as much as 10% over a temp range of 75°–225° F, although the general slope is the same. The effect on *Rmf* and *Rmc* has also been investigated, and the results are presented in a series of graphs. Six refs. C. A. F.

715. Magnetic particle inspection pays off. W. A. Henkes. *World Oil*, Jan 1961, **152** (1), 94.—Magnetic particle inspection is now being carried out as a routine operation by many companies for determining faults in drilling equipment due to weld failures. The method consists of magnetizing the part to be inspected by prods at each end and using a high amp, low volt controlled electrical source to create a magnetic field between them. Magnetic particles are then blown over the surface or flowed on as a liq suspension. The particles are concentrated by polarity at any discontinuity which becomes readily apparent. Average cost of a thorough inspection for a mast is *ca* $250. Masts should be inspected every two years at least, and more frequently if hard drilling is carried out. Examples of recent inspections are described.

C. A. F.

716. Time-setting clay cement controls lost circulation. J. U. Messenger. *World Oil*, Jan 1961, **152** (1) 110.—When bridging or mud plastering agents are ineffective for controlling lost circulation it is necessary to use cement, and in order to overcome the disadvantage of neat, gel, or quick set cement, a time-setting clay cement has been introduced. This has many properties for combating severe lost circulation, tendency to stick drill pipe, or contamination of drilling fluids. It consists of a specially selected clay, aluminium silicate, and a retarder; the clay has a tendency to time-harden when hydrated. Initial slurry properties, thickening characteristics, and final set strengths are primarily a function of slurry composition and temp of application. There is therefore much control over the final properties of the clay cement. Details of properties and applications of the cement are given with field examples. It can be applied against permeable zones with minimal change of formation properties, and the high gel strength of the slurry resists dilution or erosion by formation fluids. It can be used effectively against induced and natural fractures, but it does not provide any anticipating protection, so it is not recommended for use against zones that can be bridged or plastered with conventional mud additives. C. A. F.

717. Protecting cement jobs. S. J. Martinez. *Oil Gas J.*, 9.1.61, **59** (2), 96.—In selective formation fracturing, conventional ball sealers used to plug one set of perforations while another is being squeezed allow high pressure gradients across the cement behind the casing. If the cement is cracked, further damage, and also channelling of the fracture fluid, may ensue. A new permeable type of ball, composed of plastic-bound walnut shells, removes this danger. The permeability is sufficient to prevent dangerous pressure differences building up, but low enough to ensure that the bulk of the injected fluid is diverted to the zone desired.

J. C. M. T.

PRODUCTION

718. Advancements in production methods—1960. R. W. Scott. *World Oil*, 15.2.61, **152** (3), 74.—Many new production methods and tools were introduced in 1960 with the main aim of reducing production costs and increasing efficiency. Reduction in size of surface and subsurface equipment has permitted miniaturization, and most downhole equipment is now available in small sizes, *e.g.* $2\frac{7}{8}$-inch casing and $\frac{1}{2}$-inch rods. The first sextuple well was completed in 1960 in which three strings of $2\frac{7}{8}$-inch casing were run in the hole and fitted with $1\frac{1}{2}$-inch tubing strings and packers. Small dia wells can, however, present difficulties in serious completion problems.

The first underwater deep sea completion is reported from offshore Peru. The well was drilled in 132 ft of water *ca* 6200 ft offshore. Nitrogen has been increasingly used for various purposes, such as perforating and in fracturing and

acidizing. Recent logging developments include the cement bond log, which uses a sonic sonde to detect top and variation in cement behind casing. A magnetically positioned perforator has improved efficiency of small through-tubing capsule-type guns. Other developments briefly noted include the use of aluminium particles and implosion capsules in well stimulation and the development of automation for lease production. 15 refs. C. A. F.

719. Study of the spontaneous displacement of one fluid by another in a porous medium. (In French.) M. Lanchon. *Rev. Inst. franç. Pétrole*, 1960, **15**, 1401–39.—By making various assumptions about pore form and size distribution, the displacement of oil from a porous block by slow water rise in surrounding issues can be computed. Low recoveries are indicated for a water rise of 24 ft pa.

Experimental means have been devised for making measurements on oil displacement as water rises slowly around the specimen, these measurements being made while the specimen is surrounded by water and partially by oil. For a stepwise water rise the rate of displacement was almost linear, after a high initial rate, down to a final saturation of *ca* 60%. Tests were made with different rates of water rise for samples which were water-wet and samples which were oil-wet. The desaturation curves were rather irregular. Generally the water-wet cores showed greater desaturation at a given time than those which were oil-wet, and desaturation rates rose with rate of water rise.

Wettability has been assessed via the measurement of contact angles for drops, displacement pressures, and combined imbibition and centrifuging behaviour. However, the preparation of specimens is apt to alter the original surface properties. Exploratory measurements have been made using capillary ascent.

Imbibition into loose sands in a brass container having failed, iron mesh, water-wet filter paper, and nylon holders were tried. A brass container on Vosges sandstone gave *ca* 10% less displacement than for the sandstone without a holder.

Addition of a wetting agent to the water greatly increased the displacement. For glass granules of 5 mm dia water displaced 65% of the oil; for 0·5 mm dia the figure was 5%. A possible container for sand might be large-mesh brass with a layer of glass spheres inside, thereby reducing the influence of brass wettability. G. D. H.

720. Mathematical study of drainage in a heterogeneous reservoir. (In French.) P. Jacquard. *Rev. Inst. franç. Pétrole*, 1960, **15**, 1384–400.—The two-layer problem studied involves sheets of uniform thickness which differ in permeability and porosity; they are charged with the same fluid, have no fluid flow into the upper and lower boundaries, or from beyond a given radius around the well. A constant flow from the well is assumed. The methods discussed can be adapted to multi-layer systems; they are presented in generalized form and no numerical examples are given. G. D. H.

721. Method of estimating reserves. (In French.) P. Albert. *Rev. Inst. franç. Pétrole*, 1960, **15**, 1641–7.—In a field which has been outlined by a few wells it may be possible to estimate the oil in place volumetrically. The values obtained in this reconnaissance phase may differ considerably. However, when there are more wells and the field is on production the estimates will lie within narrower limits as production proceeds. Material balance considerations applied to a series of successive states of equilibrium can yield figures for the hydrocarbons in place. Fluid mechanics applied to well behaviour can also yield figures for recoverable oil. It can be shown that after a certain time the pressure decline at the bottom of a well is simply related to the reserve drained by the well. For a reservoir of the Hassi-Messaoud type the period is of the order of ten months. The attainment of a pseudo-permanent regime is characteristic of all forms of closed permeable zones. A circular drainage area is not essential to this behaviour. The rate of drop in pressure is linked with the ratio of the production and the oil in place. G. D. H.

722. Journal survey of proved reserves. Anon. *Oil Gas J.*, 30.1.61, **59** (5), 126–33.—The estimated remaining reserves of crude oil and condensate for the larger fields of the U.S.A. are listed. Also given are the 1960 and cumulative production figures, and the number of wells. J. C. M. T.

723. New type of iron bacteria found in salt water. J. M. Sharpley. *Oil Gas J.*, 23.1.61, **59** (4), 89–90.—The iron bacterium Gallionella is a known cause of corrosion in fresh water, to which it was thought to be confined, but has recently been found flourishing in salt water containing less than 0·1–0·3 ppm dissolved oxygen in the Long Beach area, California. The water is drawn from wells in the former bed of the Los Angeles River, now flooded by the sea, and approximates to the comp of sea water. Gallionella assists corrosion either by providing anaerobic conditions favourable for the development of sulphate-reducing bacteria, which cause pit corrosion, or by setting up differential aeration cells, causing anodic attack. J. C. M. T.

724. Special sucker-rod pumps. J. Zaba. *Oil Gas J.*, 6.2.61, **59**, 129–30.—Sucker-rod pumps for handling large vol of fluid are of two kinds. The older type is the casing pump, but rod wear on casing is a problem. A newer development is the double-displacement pump, which employs two plungers arranged in tandem. The increased loads on the sucker-rods impose a limit to the depth at which these pumps may be used. A special pump developed for gas interference employs the principle of two-stage compression of the gassy fluid within the pump, using two plungers in tandem, this time of different sizes. In some designs the valves are arranged to open and close mechanically with the movement of the rod. Pumps for severe sand conditions use a fluid seal of considerable length and large clearance to avoid abrasive scoring. J. C. M. T.

725. New technique increases core recovery. C. E. Knutson, E. W. Sutton, and R. J. Cavanaugh. *World Oil*, 1.2.61, **152** (2), 37.—A rubber sleeve core brl has recently been introduced, and field experience shows that it recovers 90% or more from such unconsolidated sands as the Miocene of the Gulf Coast and the basal McLish of Oklahoma. In the past, recovery with conventional barrels in these formations was 20% or less. These rubber sleeve brl provide in general an excellent means of coring soft sands, but samples are no less contaminated than in the conventional brl. Shipping and lab study of the cores are, however, facilitated by enclosure in the rubber sleeve. These conclusions are reached following tests carried out on 15–20-ft cores taken through soft sands in the Gulf Coast and Oklahoma. Tables show comparison of results of core analyses obtained by different coring techniques.

The rubber sleeve brl has also been used to recover fractured carbonates, and it has given higher recoveries than conventional methods in the same zones. This was invaluable for studies of matrix and fracture permeability. C. A. F.

726. Radioactive gas tracer aids water flood planning. W. D. Howell, F. E. Armstrong, and J. W. Watkins. *World Oil*, 1.2.61, **152** (2), 41.—The directional trend of fractures in the Spraberry sandstone reservoir of W Texas has been confirmed by a radioactive gas tracer survey. The tracer gas was detected at two wells approx parallel to a NE–SW line predicted as the trend from core fracture orientation. The gas

was tagged at 0·03 microcuries/cu ft and injected for 12 weeks at 500 Mcfd under pressures of 850–1000 psi at 150° F; a slug of two curies was injected at the thirteenth week and one curie at the fourteenth. Injection was stopped at the end of the sixteenth week. The method was very successful, detection techniques and instruments operating continually for long periods with little necessary attention or maintenance. Data obtained from the survey will be used in the planning of a water injection unit for spacing and locating water input wells so as to give optimum sweep efficiency of injected water and hence max oil recovery. The technique should also be applicable to tracing reaction and flow in other production methods, such as pressure maintenance by gas injection and solvent injection. Three refs. C. A. F.

727. Flowing well logs can save you money. H. L. Bryant. *World Oil*, 1.2.61, **152** (2), 33.—Well logging under flowing conditions in the borehole can be very useful in solving production problems and in the evaluation of production conditions. Flowing neutron and fluid density logs can be run to locate gas and water entry, and borehole flow profiling can indicate the amount, direction, location, and type of fluid flowing into or from a well bore. Flowing profiles can be obtained by various devices such as temp surveys, electrical methods, and metering devices, but no single method is satisfactory for all operations. A recent development, the inflatable packer flowmeter, has been used successfully for profiling injection and production wells. Details of the techniques are given.

For successful logging in flowing wells the tubing must be unobstructed, the logging tool must have a small enough dia, and the well must be entered without disturbing flow conditions. C. A. F.

728. Peripheral and line-drive water-injection projects. F. Stephens. *J. Petrol. Tech.*, Dec 1960, 16–19.—At Sojourner, Haskell County, Texas, the Strawn sand, at 5100 ft, has porosity of 14% and 12 mD average permeability. Peripheral injection with wells taking 600–900 bd at 600 psi surface pressure in sand-fractured wells seems not to have involved premature breakthrough. A recovery of 1,145,029 brl of oil has been associated with the injection of 11,258,350 brl of water.

Glen Cove, Coleman County, involves end-to-end water injection with gas recycling. The Strawn, 3400 ft deep, has 14·5% porosity and 137 mD permeability. A low GOR oil front *ca* one location wide seems to be maintained ahead of the water front. Cumulative water injection of 5,403,957 brl has given 1,979,000 brl of oil and 177,000 brl of water. 3–8 months after water breakthrough wells become noncommercial. Acme, Clay County, is a peripheral flood of the Mobley Strawn sand at 4000 ft. The porosity is 14·9% and permeability 18·4 mD. The sand has three main producing lenses. 5,834,993 brl of injected water has been associated with 983,255 brl of oil production. The Nail, Shackleford County, Upper Cook sand projects are peripheral. Porosity averages 20% and permeability 400 mD. As elsewhere wells in the centre of the project have had little benefit to date. $1{\cdot}5 \times 10^6$ brl of water have been injected with the recovery of 4×10^5 brl of oil.

The various projects differ widely in spacing and regularity of wells. G. D. H.

729. Factors affecting water flood pattern performance and selection. P. B. Crawford. *J. Petrol. Tech.*, Dec 1960, 11–15.—Injectivity diminishes from seven-spot through five-spot to line drive for different spacings, but at a given well density five-spot gives the highest injectivity. Sweep efficiency is 72% for five-spot, and 37 or 73% for line drive, depending on whether direct or staggered.

Injection needs to be balanced to avoid early breakthrough from one side of a producer in five-spots. Mobility ratio affects the swept area and fractional water cut. At breakthrough five-spot is better than line drive, but at two pore vol injection the swept areas are similar for mobility ratios of 0·4 upwards. Heterogeneity of the reservoir affects results.

Lab tests on loose sand models $10 \times 10 \times \frac{1}{4}$ inch with oil/water visc ratio of 1·6, 25% initial water saturation, showed recovery after two pore vol injection to be independent of pattern when the initial oil saturation did not exceed 50%; at higher oil saturations five-spot was better than line drive. For nine-spot sweep efficiency is 45–99%, depending on producing-injection scheduling, according to early work. Five-spot and nine-spot studies showed little difference for high water/oil ratios, but the latter was superior in the early oil recoveries.

At constant initial oil saturations sweep efficiency increased with decrease in interstitial water; at constant interstitial water sweep efficiency increased with decreased initial oil saturation. G. D. H.

730. Displacement of oil by rich-gas banks. C. W. Arnold, H. L. Stone, and D. L. Luffel. *J. Petrol. Tech.*, Dec 1960, **12** (12), AIMME Tech. Paper No. 8138, 305–12.—Tests were made at 160° F and 2500 psia in sand-packed tubes ¼-inch dia, and 7 and 20 ft long. Decane was the liq displaced by methane and usually butane as the rich gas, followed by methane. 0·1 and 0·2 pore-vol banks of methane with 25% *n*-butane gave essentially 100% decane recovery; there was incomplete recovery with 0·05 pore-vol, but methane alone gave only 50% recovery at two pore vol flow. Small banks deteriorate to give immiscible displacement. Large banks travel through the sand at essentially the same rate as the total gas rate; small banks move more slowly. 0·1–0·2 pore-vol banks seem necessary to give recoveries comparable with continuous injection of rich gas. Gases with two intermediates were less effective than the same amount of methane and one intermediate.

For miscible displacement to continue through a column, the rich-gas bank should be large enough to prevent the peak concn falling below the minimum for miscibility. For cases of no by-passing, the dispersion of an oil-miscible, enriched-gas bank is controlled by diffusion and convection of the solvent in oil. G. D. H.

731. Determination of fracture orientation from pressure interference. L. F. Elkins and A. M. Skov. *J. Petrol. Tech.*, Dec 1960, AIMME Tech. Paper No. 8137, 301–4.—The Spraberry sandstone has a permeability under 1 mD, but vertical fractures improve fluid transmission. Under 10% of the oil is recovered by primary methods. Imbibition suggests the possibility that water flooding will considerably increase recovery. Initial pressures were measured on 71 wells in a five-mile long area on completion. Improved agreement with observations was obtained when permeability anisotropy was included in the analysis of the behaviour. The trend indicated agrees with fracture trends indicated elsewhere by fluid-injection tests. The trend is roughly NE–SW for an area 17×12 miles in extent. The indicated permeability ratios were 6–144. G. D. H.

732. Progress review of the K & S carbonated water flood project. C. W. Hickok, R. J. Christensen, and H. J. Ramsay. *J. Petrol. Tech.*, Dec 1960, **12** (12), 20–4.—The K & S project, 10 miles N of Bartlesville, covers 240 acres with 35 input and 24 producing wells on a ten-acre five-spot pattern. The Bartlesville sand at 1250 ft averages 33 ft thick, 17·6% porosity, and 56 mD permeability. Primary production from 1905 to 1934 gave 438,000 brl of oil; production ceased until 1951, when a dump flood of one input and 14 producing wells operated, giving 74,000 brl of oil, probably mainly as a result

of improperly plugged wells allowing water entry during the closed period. The primary recovery mechanism was dissolved gas drive. Tests on cores gave a residual oil saturation of 21·4% by water flood and 11·4% by carbonated water flood of *ca* two pore vol. Blowdown gave no additional oil. 13,000 bd of water is obtained from the Arbuckle and Roubideaux, and is supplemented by produced and river water. Aeration, chemical treatment, and filtration take place. CO_2 is obtained by burning natural gas, and extracting with monoethanolamine. Mixing with brine occurs at the sand face. Injection began in Feb 1958. Wells increased in injectivity, and it is now 700 bd/well, being better than for water alone. Serious water losses have occurred to the transition zone and lower water sand; there was some loss to the gas sand. Substantial oil production rise was noted in June 1958; a well rose from 5 to 214 bd of oil. 17 wells have had large fracture treatments and the produced water/oil ratio has risen from 1 to 4, with the production of 611,000 brl of oil. There have been no exceptional corrosion or emulsion problems; fracturing may have led to water cycling. G. D. H.

733. How to improve your hydraulic pumping operations. J. B. Woods. *World Oil*, Jan 1961, **152** (1), 85.—The efficiency of hydraulic pumping installations can be improved by proper interpretation of hydraulic dynamometer cards, and the use of the dynamometer and card interpretation are discussed. Analyses of cards show that downstroke time in a single acting pump has a definite relationship to fluid vol at the production end; this can also be shown theoretically. Examples of cards are given. C. A. F.

734. How to estimate equivalent gas volume of stock tank condensates. A. G. Leshiker. *World Oil*, Jan 1961, **152** (1), 109.—A chart is presented for rapidly converting monthly condensate production to its equivalent gas vol, in order to obtain data for reporting gas-condensate production in terms of full well stream gas vol rather than residue gas vol. Basic data for using the chart are lease separation pressure and API gravity of stock tank condensate. The equivalent vol obtained includes gas vented from low pressure separators and gas flowed at reduction of pressure into stock tanks. C. A. F.

735. Many geologic factors govern water floods. H. W. Yeager. *World Oil*, 1.2.61, **152** (2), 46.—A main consideration in planning a water flood is the determination of the original oil content of the reservoir and the amount that may be recovered at the end of the flood. Geological data are invaluable in this work, assisting the determination of factors affecting oil accumulation, form and size of the reservoir, and nature of drive. Mineralogical composition of the reservoir rock and chemical composition of crude affect the recovery under water flooding, *e.g.* quartz and calcite, normally hydrophylic, can become preferentially oil wet under certain types of crude, so that the irreducible minimum oil saturation by water flooding could vary substantially, depending on whether the reservoir rock is hydrophylic or hydrophobic. Type and abundance of clay minerals are also important, as they affect relative permeability. Geological conditions also influence selection of source and supply of water for flooding, and it is important that the injected and interstitial waters are compatible. If not there is danger of plugging at sand face, involving increased treating costs. Sandstone waters are usually sweeter than limestone waters, the latter often containing more H_2S. C. A. F.

736. Salt plagues Montana production. W. B. Bleakley. *Oil Gas J.*, 6.2.61, **59** (6), 107–8.—In the E Poplar field, Montana, the producing Madison formation is overlain by a salt bed up to 40 ft thick. When the field was first put on production, produced water from the W side was much more saline than elsewhere and soon reached saturation, and this high salinity gradually encroached eastwards. Tubing and flow lines began to plug with precipitated salt. To prevent this, fresh water is injected into the annuli of wells when the salinity reaches 200,000 ppm. J. C. M. T.

737. Technical-operating details of production operations in Algeria's Hassi Messaoud field. R. J. Rousseau. *World Oil*, 1.2.61, **152** (2), 23.—Drilling problems faced in the development of the Hassi Messaoud field include lost circulation, high pressure salt water flows, and ineffective stimulation treatments. In order to overcome these the present practice is to use a four-phase mud programme for each well, permanent type well completions, calcium nitrate packer fluid, and experimental fracturing techniques. Three rigs are used to complete a single well. Details of these procedures are given.

Hassi Messaoud is *ca* 450 miles SE of Algiers and produces from Cambro-Ordovician sandstone, which has, broadly, three pays separated on the basis of permeability, cementation, and water saturation. The top of the productive zone is *ca* 10,700 ft, and the area of production is approx 31 miles long and 28 miles wide. The crude was formerly transported by a small dia pipe to Touggourt and thence by rail to the coast, but a 24-inch line has been built to take the oil directly to Bougie on the Mediterranean coast. C. A. F.

738. Saharan oil is bringing some changes. P. Swain. *Oil Gas J.*, 30.1.61, **59** (5), 98–100.—Rising demand in France will absorb most of the Saharan crude as soon as it reaches the market, but Middle East producers may suffer. French consumption increased by 10% in 1960 to *ca* 455,000 bd. Saharan reserves are now rated lower than in 1956. Oil in place at Hassi Messaoud is estimated at over 28 billion brl, but only 15% of this can be recovered by primary methods, giving an effective primary reserve of *ca* 3,850,000,000 brl, *ca* half the original estimate. Total Saharan potential by 1965 is estimated at 5–6 MM bd. J. C. M. T.

739. Chinese petroleum production development. (In German.) F. Slezak. *Erdöl u. Kohle*, 1959, **12**, 910–15.—World importance of Chinese coal and ore deposits was fixed in the late 19th century; petroleum research has increased truly only in our days. China was supposed to be oil-poor and foreign capital was not forthcoming. In 1898 an imperial edict illuminated the especially narrow connexion between mines and railways. After conclusion of the civil war—suppressed with Russian help—oil research implied to the People's Republic, China (1949) considerable econ construction. Russia sought advantages. From 1900 to 1948 active geologists numbered 500, in 1958 over 500 geological research groups and 12,000 geologists. In 1958 there were 270,000 geology students. Geological research was intensive in the W region, where reserves are approx equal to those of Iran. Valuable oil shales were found in 21 of 28 administrative units, *cf* the U.S.A., where oil shales contain 100 milliard tons of oil. Between the Gobi space in the N and the region Tibet–SE China in the S lie crust movements after the Triassic time with five great sedimentary basins. These Mesozoic–Tertiary and several small Tertiary basins, also the plains E of the Great Chingan mountains–Kwietschou show 14 oil-promising regions, total area 2·7 million km². China's petroleum production began only during the last war to play a notable econ role. State plans 1914–17 failed, and in 1929, of all U.S. capital investments in China 38% fell on the petroleum sector. The administration's own petroleum company, organized in 1946, which comprised all China, attracted U.S. companies, but since 1951 the petroleum industry is nationalized. A detailed description of territorial distribution of petroleum and gas deposits and shale is given. 29 refs R. T.

OILFIELD DEVELOPMENT

740. Drop in U.S. drilling in 1961 forecast. Anon. *World Oil*, 15.2.61, 152 (3), 69.—46,079 new wells are expected to be completed in the U.S.A. in 1961; this would be 699 (or 1·5%) less than in 1960, but there should be a gradual improvement later in the year in domestic demand. U.S. crude oil prices have stabilized and made a limited recovery. A table shows wells completed annually in the U.S.A. since 1940. C. A. F.

741. U.S. crude production to set new record in 1961. Anon. *World Oil*, 15.2.61, **152** (3), 81.—Production in the U.S.A. in 1961 is expected to reach a new record of 7,210,000 bd, or 2·7% more than in 1960. Output was down sharply in 1958, but recovered substantially in 1959. In 1960 it fell again, but there is expected to be a significant recovery in 1961. There should be a better market for crude, mainly because of increased demand for oils and also because less will be supplied by storage withdrawals and imports. Tables show U.S. crude oil production by states and districts, for 1959 and 1960. C. A. F.

742. Anido may stir Paradox Basin areas in 1961. F. J. Gardner. *Oil Gas J.*, 23.1.61, **59** (4), 137.—Important discoveries have recently been reported from the S part of the Paradox Basin in Utah. All these were during the first month of 1961, in spite of the fact that no major fields were found in the state in 1960. Of four recent finds, the Anido Creek well found oil in Pennsylvanian Ismay at *ca* 5300 ft, and 58-1 Navajo found oil in Desert Creek at *ca* 5600 ft. Prospects for 1961 in the Paradox Basin are improved, and many wildcats are expected to be drilled to Pennsylvanian, Mississippian, and Devonian targets. C. A. F.

743. New world's depth record a possibility in 1961. Anon. *World Oil*, 15.2.61, **152** (3), 72.—The world's deepest well is in W Texas, but a new well is being drilled in the Lake Washington field, Plaquemines Parish, Louisiana, which will beat this record if the projected depth is reached. Present record holder is University EE-1 in Pecos County, Texas, at 25,340 ft (1958). Deepest well in 1960 was Walker 1 in Webb County, SW Texas, which reached Edwards limestone at 20,603 ft. Tables show regional drilling depth records and holders of records as deepest test in the U.S.A. C. A. F.

744. Newest nation has big oil potential. J. C. McCaslin. *Oil Gas J.*, 23.1.61, **59** (4), 138.—Nigeria has become the fourth largest oil producing country in Africa, output now averaging 15,500 bd. Other major producers are Egypt, Algeria, Sahara, and Gabon. Regional geology consists of areas of basement rocks with interior basins, coastal fringes, and marine embayments. Most of the fields are near the Niger Delta, and best prospects are in Tertiary and Cretaceous sediments in the coastal embayments. Similar regional conditions are found in the Spanish Sahara, Senegal, Gabon, and elsewhere in W Africa. Six oilfields have been found by Shell–BP, and total exploration cost to date is *ca* $175,000,000. Largest field is Bomu, producing over 8000 bd, and other fields have been found at Oloibiri, Afam, Ebubu, Okoloma, and Elelenwa. A wildcat at Ughelli has also recently been successful. Statistics of the Nigerian oil industry are presented. C. A. F.

745. France moves to diversify Sahara crude oil markets. Anon. *World Oil*, Jan 1960, **152** (1), 83.—It is hoped that exploration permits issued for the Sahara in 1960 will attract capital from new companies, particularly from Italian and W German sources. Details of the distribution of ownership of nine new concessions units issued in Aug 1960 by the French Government are given. C. A. F.

TRANSPORT AND STORAGE

746. Mobility plus sharp ideas speed Transwestern work. M. A. Judah. *Pipe Line Ind.*, Aug 1960, **13** (2), 22–9.—Details of techniques used in the construction of a gas pipeline system from Texas to California are reported. These include the welding of 30-inch X56 pipe, the handling of 80-ft lengths, and rock blasting. G. B.

747. Stations slick, efficient, and push-button controlled. D. M. Taylor. *Pipe Line Ind.*, Aug 1960, **13** (2), 30–8.—The design of the pumping and control systems of the Transwestern Texas to California gas pipeline are described. All pumping stations are controlled from one console with the aid of an analogue computer. G. B.

748. Strict specs met in bell-hole job. M. A. Judah and D. G. DePugh. *Pipe Line Ind.*, Aug 1960, **13** (2), 39–45.—The techniques used in constructing a gas pipeline across the Mojave Desert. The chief adverse condition was high operating temp. G. B.

749. Injecting volatiles into crude lines automatically. P. R. Scott. *Pipe Line Ind.*, Oct 1960, **13** (4), 35–9.—The successful use of a vapour pressure recorder and controller for maintaining the correct blend of volatile products transported in crude oil pipelines is reported. The sensing element is an ejector which works on the principle of increasing the kinetic head until the static head at the nozzle reaches the vapour pressure. Control is achieved by automatic operation of the volatile products injection valve. G. B.

750. Liquid methane behind the Iron Curtain. II. C. I. Kelly. *Petrol. Times*, 27.1.61, **65**, 97–8.—The storage and distribution facilities for liq methane at the LSR plant in Moscow are described. The use of liq methane in motor vehicles has been proved both economical and safe. Two tanks are fitted to the vehicles with a capacity of 40 l, and these are either insulated with a vacuum jacket or with fragmented and compressed insulants. As a result of successful experiments with liq methane in lorries, some 2000 lorries and omnibuses are expected to be operating by 1967 in the Moscow area.

A liq methane road tanker designed to supply fuel directly to tanks on motor vehicles is described. A brass inner vessel having a 1000 kg pay-load is suspended in six vertical chains inside the outer shell, the space between being packed with slag wool or Mipora. All fittings, control and measuring instruments are mounted together in a single lockable cabinet on the lower part of the rear end of the shell. Evaporation losses during transit were *ca* 1%/hr for slag wool and 0·5%/hr for Mipora. A. D. S.

751. Origin of the transportation of liquefied methane. M. Freund. *Petroleum, Lond.*, 1960, **23**, 215.—Projects for the transportation of liq methane were conceived as early as 1934 by the author for a small well in Hungary. This was the first step in this modern transportation method. (Author's abstract.)

REFINERY OPERATIONS

REFINERIES AND AUXILIARY REFINERY PLANT

752. Combined installation for SO_2-selective-extraction of kerosine, gas oil, and lubricating oil distillates in Sacor refinery, Lisbon. (In German.) H. Sprenger and G. Scholten. *Erdöl u. Kohle*, 1959, **12**, 895–7.—Sacor refinery for SO_2-extraction processes kerosine, gas oil, and lub oils. Advantages are small energy requirement and small solvent loss, giving low operating costs. SO_2, available in almost every refinery with a cracking or desulphurization plant, is cheap. SO_2 production offers the possibility of recovery of H_2SO_4 required in the refinery. Investment costs for the SO_2-extraction installation are low, since solvent bp is low and solvent can be used for direct cooling. Almost the entire installation can be constructed of straight C-steel. R. T.

753. Sand slurry scours condensers at Sinclair's Hartford, Illinois, refinery. K. Brooks. *Oil Gas J.*, 9.1.61, **59** (2), 70–1.—Since Sinclair started to employ sand-slurry cleaning *ca* five years ago they have not found it necessary to go inside a condenser to clean the tubes. The slurry, a mixture of air, sand, and water, is blasted under a pressure of 100 psig into the system and then exhausted into a drainage ditch. It takes *ca* 15 min to clean a large exchanger, *ca* 2 cu ft of sand being used in the operation. Key to successful operation is to do it often and before the scale becomes too hard and thick to sandblast effectively. Wear and tear on the tubes is of a minor nature. A. D. S.

ABSORPTION AND ADSORPTION

754. How to add refrigeration to existing gas-processing plants. C. P. Stanley. *Oil Gas J.*, 9.1.61, **59** (2), 88–9.—Main advantages of refrigeration over atmospheric temp processing are the saving of plant fuel and reduction in capital investment, operating labour, and operating difficulties. In order to increase propane extraction in existing gasoline plants by refrigeration the following steps are normally used. Dehydrate inlet gas or use glycol injection; add refrigeration system to refrigerate both oil and gas; add heat exchangers to oil and gas from absorber to recover refrigeration; and eliminate steam stripping by using lower mol wt absorption oil and use of furnace heat at the still base for oil stripping.

An actual plant case, which has recently been studied, is discussed. A. D. S.

CRACKING

755. Economical paraffin hydrocarbon cracking in the electric arc. (In German.) F. Cagaš, M. Štaud, and A. Lazarev. *Erdöl u. Kohle*, 1959, **12**, 818–23.—Two new principles are applied for producing unsaturated hydrocarbons, *e.g.* acetylene, by cracking paraffinic gaseous hydrocarbons in the elec arc. In the first process an ac arc is used instead of the dc arc used formerly, whereby investment costs for the supply circuit are reduced by 66% and total costs by 15%. A two-stage process was developed which utilizes the energy previously lost for further chem reactions. Thereby water quenching of production gases in the elec arc chambers is replaced by cooling by a paraffinic hydrocarbon spray, whose cracking temp is lower than that of CH_4. Resulting from decomp of these cooling hydrocarbons, the production gas is enriched in unsaturated hydrocarbons without further energy introduction. The two-stage process is applicable to different types of pyrolysis, and in the partial oxidn of hydrocarbon gases. Using this process and preheating the gas fed into the elec arc, the C_2H_2 produced is cheaper than that by any other process. In the single-stage process energy consumption is 11–13 kWh/kg C_2H_2. In the two-stage process 10–11 kWh/kg C_2H_2 and 7–8 kWh/kg $C_2H_2 + C_2H_4$. Eight refs. R. T.

756. Thermal-catalytic Otto tube-cracking process for town and industrial gas production. (In German.) K. Osterloh. *Erdöl u. Kohle*, 1959, **12**, 815–18.—Gases for provision and synthesis purposes can be produced by cracking-gasification of light hydrocarbons in Otto tube furnaces by a technically simple procedure. The installations work thermo-catalytically, and are suitable for gaseous and low-bp hydrocarbons up to *ca* 150° C boiling end. Feed is limited to this temp because the low-bp materials formed by decomp are simpler to manipulate than high-bp residual oils. No by-products result, and the gas produced contains no naphthalene. The installations can be adjusted in size and—thanks to their very elastic operation—also in processing the special requirements. Eight refs. R. T.

757. Reaction-mix sampling simplifies analysis of cat cracker for California Standard. R. L. Flanders, R. J. Annesser, and D. A. Saville. *Oil Gas J.*, 9.1.61, **59** (2), 84–6.—The reaction-mix sample method is based on withdrawing a sample of the hot reactor-effluent vapour, cooling it, then measuring and analysing the resultant gas and liq portions.

A steel sampling probe is pushed into the reaction-mix line through the packing gland and block valves. After purging, the sample is drawn at a slow enough rate so that all of the sample over a period of *ca* 20 min can be processed through the sample-recovery train. Samples of plant feed, recycle, and other stream samples are drawn in sufficient vol to provide all inspections required. A sample of the flue gas is analysed for CO_2, CO, and O_2 by Orsat or chromatograph. An analysis scheme for the liq hydrocarbon sample involving the mass spectrometer or gas chromatograph is presented.

An accurate description of plant performance can be obtained by combining the analytical results with three plant flow rates. These flow rates are obtained from meter readings of the fresh-feed, recycle, and regenerator-air rates. A. D. S.

SPECIAL PROCESS

758. Progress report on Tidewater's big hydrogen plant. D. H. Stormont. *Oil Gas J.*, 9.1.61, **59** (2), 90–2.—Three years experience with the oil industry's largest hydrogen plant operated by Tidewater has shown that such plants offer a dependable, efficient source of hydrogen. The plant consists of two essentially parallel units of 15 MMcfd capacity. In the reforming furnaces the hydrocarbon feed and steam are converted into H_2, CO_2, and CO. The hot gases are cooled and run to the first-stage shift converters, where more H_2 is produced as a result of the steam–CO reaction. Most of the CO_2 is removed in hot-potassium carbonate scrubbers and gases are again mixed with steam and run to the second-stage shift converters. CO_2 produced is removed by scrubbing with MEA soln. Purity of the product has run as high as 99% plus.

The reforming furnaces are described and an unusual corrosion problem discussed. A. D. S.

PRODUCTS

CHEMISTRY AND PHYSICS

759. Reactions on metal surfaces at high temperatures. F. T. Barcroft and J. R. Hayden. *Nature, Lond.*, 1961, **189**, 133.—A method of assessing the EP activity of lub oil additives by measuring their reactivities towards metal surfaces at high temp is described.

In principle, an electric current is passed through a thin metal wire immersed in an oil containing the EP additive. The wire temp is obtained from its resistance, and the reaction rate is obtained from the increase in resistance of the wire as a result of chemical attack. When a continuous current is passed, the method is limited to temp no higher than the bp of the oil; however, higher temp can be attained by passing short pulses of current (duration 10^{-3} sec each) so that the lub oil is never hot enough to vaporize. The apparatus is briefly described.

Results for the system stainless steel/MWO containing S and dibenzyl disulphide as EP additives are given for temp between 650° and 1110° C. Over this range the log of the initial reaction rate is inversely prop to the abs temp.

H. C. E.

760. Oil-soluble surface-active copolymers of alkenes and polar monomers. F. M. Fowkes, M. J. Schick, and A. Bondi. *J. Coll. Sci.*, 1960, **15**, 531–45.—Oil-soluble surface-active copolymers of α-olefins and a polar cpd such a vinyl alcohol or vinyl acetate were prepared with 1–5 polar groups per hydrocarbon chain and a mol wt of 10,000–40,000. In hydrocarbon soln the molecules aggregate in clusters of *ca* 10 mol; in polar solvents the mol are more extended.

The dispersant properties of these polymers in hydrocarbons were measured by comparing the electrical resistance of a 10% carbon black oleogel containing the polymer with that of a suspension of the same carbon black in MWO. Resistance measurements showed that the polymers are adsorbed on the carbon black as a unimolecular layer of thickness *ca* 20 Å. The polyalcohols have a large ratio of polar to alkyl groups, and were effective dispersants at temp up to 150° C.

H. C. E.

761. Hydrogen diffusion in water-accelerated rolling surface fatigue. L. Grunberg *et al. Nature, Lond.*, 1960, **188**, 1182.—It is known that the presence of water in mineral lub oils can accelerate the failure of ball bearings. To investigate this effect, four-ball tests were carried out with a lub oil containing 6% tritiated water of activity 5 c/ml. After test the balls were washed with acetone and partially immersed in a liq scintillator. When the part of the driving ball carrying the fatigued track was immersed, counting-rates of 1000–2000/sec were recorded, and this decreased with time. The unfatigued part of the driving ball gave counts of *ca* 40/sec, and the background count was 30/sec. These effects suggest that, in the presence of water, hydrogen penetrates into the material subject to surface fatigue. The subsequent decrease in activity is attributed to escape of tritium from the material.

H. C. E.

762. Ethyl branching in the Fischer–Tropsch synthesis. B. D. Blaustein, I. Wender, and R. B. Anderson. *Nature, Lond.*, 1961, **189**, 224.—Following the reaction of H_2 and CO over a reduced-iron cat at 260° C and 21·4 atm, hydrogenation of the product, and dist into narrow fractions, a small amount of 3-ethylpentane was found. Ways by which this mol might have been formed are briefly discussed.

H. C. E.

763. Stability of emulsions of water in oil. III. Flocculation and re-dispersion of water droplets covered by amphipolar monolayers. W. Albers and J. Th. G. Overbeek. *J. Coll. Sci.*, 1960, **15**, 489–503.—Theoretical calculations demonstrate that emulsions of water in oil cannot be sufficiently protected against flocculation by an adsorbed layer of amphipolar molecules with an oleophilic chain length of *ca* 20 Å. Theory shows that such flocculated emulsions can be re-dispersed by moderate rates of shear, and this is confirmed by visc measurements. Non-Newtonian behaviour found at low rates of shear is a consequence of flocculation. From the min rate of shear to reach the Newtonian region, *i.e.* to cause re-dispersion, the effective van der Waals const A between the water droplets can be estimated. The rather low value of $A = 0{\cdot}4 \times 10^{-14}$ erg is found. (*Cf* Abs **794**, 1960.)

H. C. E.

764. Refractometric process regulation for increasing the purity of fine fractionation products. (In German.) G. J. Fraade. *Erdöl u. Kohle*, 1959, **12**, 976–9.—Use of a registering refractometer in fractionating-dist sphere to ensure satisfactory purity of competitive materials is discussed. The procedure is exemplified by the examples of C_5H_{12} and C_6H_{14} separation. Supervision costs for such products—required very pure—are covered quickly, and permit rapid amortization of the purchase price of an instrument developed for industry.

R. T.

ANALYSIS AND TESTING

765. High temperature gas–liquid chromatography. Exploratory studies using an ionization detector chromatograph. B. J. Gudzinowicz and W. R. Smith. *Analyt. Chem.*, 1960, **32**, 1767–71.—In experiments conducted with a 6-ft silicone grease column at column temp up to 303°, inlet heater at up to 450°, and an ionization detector with a radium source, mixtures of aromatic, naphthenic, and paraffinic hydrocarbons were resolved. The isomeric terphenyls were determined on μg samples with a precision comparing favourably with that obtained by macro methods. The necessary modifications to a standard instrument are described.

G. B.

766. Identification of carbazole in Wilmington petroleum through use of gas–liquid chromatography and spectroscopy. R. V. Helm *et al. Analyt. Chem.*, 1960, **32**, 1765–7.—The presence of carbazole in Wilmington petroleum in concn $\leqslant 2$ ppm has been established. The concentrates in which carbazole was identified were obtained by two methods in one of which the temp was kept below 110°.

G. B.

767. Identification of oxygen compounds in gas–liquid chromatography fractions by catalytic deoxygenation. C. J. Thompson *et al. Analyt. Chem.*, 1960, **32**, 1762–5.—The procedure (Thompson *et al*, *Analyt. Chem.*, 1960, **32**, 424–30) for the cat removal of S from cpds occurring in petroleum to yield more easily identifiable hydrocarbons has been extended to include the removal of O. The sample, which is a fraction from a GLPC, is swept from the trap with H into a heated reactor containing 5% Pd on Al_2O_3 pellets. The product is trapped and analysed on the same GLPC column.

G. B.

768. Use of a conventional mass spectrometer as a detector for gas chromatography. L. P. Lindeman and J. L. Annis. *Analyt. Chem.*, 1960, **32**, 1742–9.—The use of a magnetic field mass spectrometer directly connected to the thermal conductivity cell detector of a gas chromatograph is described with special reference to the analysis of mixtures of petroleum hydrocarbons. The analysis of C_5–C_8 hydrocarbons in a Californian naphtha is shown.

G. B.

769. This type of container means greater safety in handling light liquid hydrocarbons. J. C. Ducommun. *Oil Gas J.*, 9.1.61, **59** (2), 77–8.—Following an accident at one of Standard Oil Co (Ind) refineries, a cttee was appointed to study the subject of sample containers for light hydrocarbon liq. The approved sample container is made of Monel metal with a pressure rating of 5000 psi. The wall stress does not exceed 24,000 psi at service pressure, and the container is equipped with suitable high-pressure forged-steel valves and is not equipped with re-entrant tubes.

General rules for sampling are laid down, including special precautions for samples of more than 300 ml. A. D. S.

770. Spectrophotometric methods for olefins. Colorimetric determination of conjugated diolefins. A. P. Altshuller and I. R. Cohen. *Analyt. Chem.*, 1960, **32**, 1843–8.—A procedure based on coupling with *p*-nitrobenzenediazonium fluoborate in a solvent medium of 2-methoxyethanol-phosphoric acid is described which is suitable for the determination of conjugated diolefins in exhaust gases or as contaminants in air. The olefins are collected by bubbling the sample through 2-methoxyethanol and the reagent, as a 2% soln in 2-methoxyethanol-phosphoric acid, is added to give a known dilution. Diolefins of the isoprene type form products which absorb strongly at 490 mμ and those of the 1,3-butadiene type at 405 mμ. Beer's law is followed between 0·3 and 30 μg and 20 and 200 μg/ml for the two types. Some interference is caused by higher aldehydes and ketones, interference by other hydrocarbons is negligible, while phenolic cpds and S and N inorganic acids interfere and should be removed. G. B.

GAS

771. Town gas production by low-temperature coal gasification in Tokio and Freiburg (Breisgau). (In German.) F. Domann and H. Schmitt. *Erdöl u. Kohle*, 1959, **12**, 883–90.—For complete, coke-free coal combustion, coupling of degassing with gasification is described. Important principles of the double gas process are described with plant illustrations. Weak gas produced in a one-shaft generator at 1000° C is passed through a thin coal layer ready for gasification. The total heat of the weak gases is too high for removal by the thin coal layer. Therefore the gases would emerge from the layer at *ca* 450°–550° C, much too high for careful gasification. At this temp tar would be overheated and cracked and would contain much pitch. 50–60% of the so-called clear gas is removed through a pipe between the gasification and low-temp shaft. The remaining 40–50% of the generator gas passes through the low-temp shaft as purging gas. Its sensible heat suffices fully to de-gas the coal in the low-temp shaft; it leaves the shaft with the low-temp carbonization gas at 100°–150° C. Whilst retaining general principles, improvements have been adopted in many countries. The special gasification procedure with carburation as it leads directly to standard town gas is described. 17 refs. R. T.

ENGINE FUELS

772. Kerosine—J. W. Rickard answers Mr Dyment. *Aeroplane*, 27.1.61, **82**, 104.—Following previous correspondence on safety factors to be employed when using JP4 and kerosine, the points detailed below are raised. Rate of flame speed; fuel mist formation; electrical arcing; spontaneous ignition temp; leaking fuel drainage; restarting after flame out; explosion limits; static; carbon deposits; and smoke generation. A. T.

LUBRICANTS

773. Temperature-resistant lubricating oils. (In German.) F. Eisenstecken. *Erdöl u. Kohle*, 1959, **12**, 829–34.—Steam engine and compressor oils undergo chem changes under temp and pressure influence. Cracking, adhesion of important machine parts, and sometimes explosions may occur. Experiments show that—for steam cyl and compressor oils—the Conradson-difference test gives a good reference pt—supplementary to conventional tests—for deciding whether an oil finally tends to cracking or explosion. Conradson-difference—independent of visc and fl pt—should be $<1(\Delta C<1)$. For compressor oils it is useful to include oxidn number and to observe—especially at high oxidn number—that only oils with low Conradson-difference should be used. Further experience—especially for high-pressure air compressors—may enable Conradson-difference and oxidn number to be coupled. 11 refs. R. T.

774. Synthetic lubricants in technical lubrication practice. (In German.) W-S. Scheel. *Erdöl u. Kohle*, 1959, **12**, 980–3.—On economic grounds Germany seized all possibilities to lessen the vast quantities of petroleum—and in some cases finished products—imported. Lignite is abundant and relatively available, and synthesis-based processes: high-pressure hydrogenation, Fischer–Tropsch synthesis, ethylene polymerization, etc., therefore are of especial interest. Synthesis in this connexion is used in a broadened sense of modern technique as understood by conventional production from petroleum over dist, deparaffining, and refining deviating processes. A review is given of developments of syn lubricants in Germany. 14 refs. R. T.

BITUMEN, ASPHALT, AND TAR

775. Influence of processing technique on bitumen structure. (In German.) G. Nyul, P. Zakar, and G. Mózes. *Erdöl u. Kohle*, 1959, **12**, 967–72.—Group composition of bitumens—Matzen, Lispe, and Nagylengyel—dist, blown, and separated with C_3H_8 from processed Hungarian crude oils, offer valuable comparison possibilities. The bitumens were decomp with aromatic-free gasoline, Fuller's earth, and chloroform into asphaltenes, oily and resinous constituents. With progressive dist of Nagylengyel bitumen the quantity of oily constituents decreases, that of resins and asphaltenes increases. Observed irregularities in bitumen blowing from Matzen and Lispe in group composition changes were investigated by treating the bitumens with aromatic-free gasoline with different aniline pt; in blowing the asphalt-rich Nagylengyel bitumen the change ran uniformly. In the blowing of materials recovered from the same material at different dist degree and with different soft pt, the bitumens obtained contained—at given soft pt—so much more oil and asphaltenes and less resins, the softer the raw material. 15 refs. R. T.

776. Investigation of a pressure-gasification tar from South African coal using new procedure. (In German.) E. Terres and H. H. Hahn. *Erdöl u. Kohle*, 1959, **12**, 823–9, 903–9. Pt II. Estimation of individual fractions of the neutral oils. Pt III. Phenol investigation.—Pt II. A detailed description is given of methods employed—adduct formation and decomp, chromatography, ir-spectrography, n, and uv-light—to determine the composition of fractions mentioned in Pt I. Results are tabulated and discussed. Seven refs. Pt III contains a detailed description of the examination of phenols decomp by NaOH from raw steam dist and the residue. Results are tabulated and discussed. Seven refs. R. T.

DERIVED CHEMICAL PRODUCTS

777. Modern method for phthalic anhydride production. (In German.) P. Sherwood. *Erdöl u. Kohle*, 1959, **12**, 890–4; 964–7. Pt I. Economic viewpoint, process problems. Pt II. Experiences in industrial operation.—Pt I. Phthalic

anhydride production in the U.S.A. rose from 51,120 tons in 1946 to 157,400 tons in 1957. More than 95% of phthalic anhydride is produced in the U.S.A. by partial vapour-phase naphthalene oxidn, and is delivered at 76°–79° C purity. Some phthalic anhydride is produced from *o*-xylene. Naphthalene scarcity—related to coke production—will result in extended use of *o*-xylene, available in almost unlimited quantities. It is won by sharp fine-fractionation from the C_8-fraction of the reformate. Economy of this process is increased by extended inquiry for the other C_8-aromatics: *p*-xylene, *m*-xylene, and ethyl benzene. Tech problems of partial oxidn of naphthalene or *o*-xylene to obtain max yield are discussed. Cat, V_2O_5 or V_2O_4, must be porous but robust. Effects of reaction temp and residence time in the reactor are considered for fixed-bed and turbulent-bed cat for *o*-xylene and naphthalene oxidn. 17 refs. Pt II. Vapour-phase synthesis of phthalic anhydride is carried out chiefly in cat fixed-bed reactors. However, since 1944 turbulent-bed technique plays a part. The turbulent-bed process—temp regulation narrow—gives higher yield and product purity. Explosion risk is lessened, liq hydrocarbons can be fed directly into the reactor; the heat exchange system is simpler and more compact. The process is less flexible, temp rise of 5–10% leads to extended maleic anhydride formation. Cat erosion is considerable, and special structural materials are required to avoid—during the running-in period—production-hindering corrosion and erosion, SO_2 addition 0·5–1·0 wt % causes with *o*-xylene *ca* 35° C temp fall. Cat particle size with id <0·18 mm causes over-oxidn. The mixture leaving the reactor must be cooled below 430° C and freed from cat. Particulars re impurities and purification of phthalic anhydride are discussed. 10 refs. R. T.

CORROSION

778. There are still ways to combat high corrosion-control costs. T. J. J. Degnan and N. K. Senatoroff. *Oil Gas J.*, 9.1.61, **59** (2), 72–6.—Cost reduction does not rule out considerations of quality, and must be based on three steps—thorough planning, careful construction, and continuous monitoring of operation. These steps are studied in detail by examining the control of environment, cathodic protection, and pipe coating. A. D. S.

779. Savings from cathodic protection. F. A. Therrell, Jr. *Oil Gas J.*, 16.1.61, **59** (3), 93–6.—This study, which is concerned only with crude oil pipelines buried in earth, is designed to present a reasonable approach to calculating the overall cost of corrosion, the cost of controlling it, and recommendations for a corrosion control programme.

In a 30·5-mile section of a loop line laid in 1920 there have been 109 corrosion leaks. The corrosion leak cost, and cathodic protection cost, and the estimated cost of reconditioning this section are shown graphically.

In an 8-inch bare line laid in 1950 the pipe showed an average wall loss of *ca* 25 miles. Cost of this corrosion on a per-mile-of-pipe basis for the period 1950–60 is compared with the estimated cost of cathodic protection.

Other examples given include the cost of installing cathodic protection and annual operating cost per mile of 12-inch bare line with conventional and with deep ground beds.

It is concluded that the greatest overall economy can be realized by applying a good coating to thin-wall pipe when practical and cathodically protecting the system by using a deep ground-bed facility. A. D. S.

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OILFIELD EXPLORATION AND EXPLOITATION

GEOLOGY

780. Oil shales—review of present economic and geological status. J. T. Greensmith. *Petroleum, Lond.*, 1961, **24**, 87.—Oil shales are widely distributed throughout the world. At present exploitation of these reserves is generally negligible. Oil shale deposits are shown to vary in age from *ca* 500 to 35 million years. Geochemical, bio-geochemical, and mineralogical studies on oil shales are being carried out, and certain hypotheses are presented as to the origin and nature of these materials. G. D. F.

781. Florida—more extensive drilling might uncover big oil and gas producing areas. W. L. Roberts and R. O. Vernon. *Oil Gas J.*, 13.3.61, **59** (11), 215.—Oil has not yet been found in important amounts in Florida although the state has a potentially favourable oil habitat. The sedimentary section is 3000–18,000 ft or more, and major structural features have been located. Drilling is, however, sparse, and little detailed sub-surface control is available. The geological setting and structure of Florida are outlined together with exploration history and stratigraphical column, and it is recommended that more extensive drilling be carried out to evaluate potential productive areas. Only *ca* 400 wells have been drilled for oil in Florida since 1900, and many of these did not reach their objective depths. Two small commercial fields have been found: Sunniland (Collier County, 1943) and 40 Mile

Bend (1953). The latter was abandoned after two producers were shut down due to technical problems. Both produced from Lower Cretaceous Sunniland limestone, which has a favourable area of development some 200 miles long and 30–50 miles wide. Six refs. C. A. F.

782. Team work is key to success in tracking down Lisbon oil. H. Budd. *Oil Gas J.*, 27.2.61, **59** (9), 154.—Although the Lisbon area of Utah can be readily mapped at the surface, complex geology effectively discouraged drilling until the discovery of oil in Mississippian and Devonian by 1 NW Lisbon in late 1959. The well was drilled on the Lisbon Valley anticline, one of five major salt folds in the Paradox Basin. The crest of the fold contains a graben with normal faulting on the S flank, and the discovery well found an accumulation on the upthrown side of the S flank. There are *ca* 3000 ft of closure at the surface. Details of the stratigraphy of the area are given. The reservoir rocks consist of Mississippian dolomites (gas condensate) and Devonian McCracken glauconitic, dolomitic sandstones, and sandy dolomites. A 1751-ft gas–oil column in Mississippian and Devonian is estimated with a gas-condensate cap and a 49° oil ring around the flanks. *Ca* 330 ft net of porous fractured carbonates have been found. Reservoir pressures are high, and the area represents the most significant discovery in the Rocky Mountain area (and possibly the U.S.A.) for 1960. C. A. F.

783. Geology of the Colchester oil pool, Southwestern Ontario. R. J. Burgess and C. J. Hadley. *Oil in Canada*, 14.11.60, **13** (2), 28–33.—The pool is a stratigraphic trap in the trough of a syncline produced by dolomitization at a fault in Middle Ordovician limestone. Production of paraffin base crude of 42° API gravity at 600 bd is from the porous secondary dolomite by solution gas drive assisted by water drive. There is no gas cap. Two separate oil–water contacts and two separate pressure systems have been established. G. B.

784. Alberta's northern push. F. J. Gardner. *Oil Gas J.*, 27.2.61, **59** (9), 153.—A recent discovery of oil on the Caribou mountain block in N Alberta has moved the Alberta oil front 200 miles farther N. The find, A-1 Melville River, on test found oil and gas in the Devonian Slave Point at 3809–3857 ft in an area *ca* 65 miles S of the NW Territories. Several early failures in the area had good showings and porosities, and the recent success has encouraged further drilling. C. A. F.

785. Two new provinces draw key wildcats. F. J. Gardner. *Oil Gas J.*, 13.3.61, **59** (11), 213.—The first wildcat is being drilled in the Bethel Basin potential oil province in W Alaska. The well, 1 Napatuk Creek, is planned to 10,000 ft and the area, which is little known geologically, is thought to hold a considerable thickness of sediments. An old aeromagnetic survey indicated a large structural trough following the Kuskowin River, but no deep wells have yet been drilled. Also the most N wildcat in Canada is to be drilled 86 miles inside the Arctic circle in the NW Territories. This well, 1 Carnwath River, is planned to 3000 ft, and a lot of seismic and photogeological work has been carried out in the area. C. A. F.

786. Geology of the Philippine Islands. B. M. Gozon. *Petrol. Engr*, Jan 1961, **33** (1), B64.—The major geological features of the regions of the Philippine Islands of interest to oilmen are seven sedimentary basins scattered throughout the islands. The general geology of these basins is reviewed. G. D. F.

DRILLING

787. Trends in drilling costs. O. E. Mechem. *Petrol. Engr*, Jan 1961, **33** (1), B19.—It is shown that the cost of wells has been greatly reduced over the cost which would be expected from historical patterns in the industry. The historical trends in cost reductions are outlined, and the further large savings possible when the latest developments are used at the earliest time practicable are clearly shown. Examples of the latter are given, and these are shown to depend on good well programming, the initiative and co-operation of the management and drilling contractor, the equipment, and making use of the latest findings of research and technology. G. D. F.

788. 1961—forecast and trends for air/gas drilling. R. W. Sneed. *Petrol. Engr*, Jan 1961, **33** (1), B34.—The present state and outlook for air/gas rotary drilling in N America and elsewhere are reviewed. No spectacular growth is predicted at present, though there will probably be a steady expansion of the method. Recent developments (*e.g.* air-percussion drilling) and possible future developments in air/gas drilling are discussed. G. D. F.

789. Modern well completion series. Interpreting nuclear logs. B. H. Goode, Jr. *Petrol. Engr*, Jan 1961, **33** (1), B50.—It is shown that the application of nuclear logs to depth correlation is important. Other uses of nuclear logs are dealt with, particularly the determination of porosity. Neutron logging is shown to be most satisfactory in low porosity formations and γ-ray logging in high porosity formations. The limitations in the interpretation of such logs are made clear. G. D. F.

790. Foaming agents and their use in air drilling. A. S. Murray and J. E. Eckel. *Oil in Canada*, 21.11.60, **13** (3), 28–30.—Foam drilling refers to the continuous injection of a soln of foaming agent into the air stream to remove formation water (up to 500 bh) and wet drilling from the well bore. The factors which must be considered are outlined. G. B.

791. Where do we stand on slim holes to-day? Anon. *Petrol. Engr*, Jan 1961, **33** (1), B90.—The results of a recent survey by the Slimhole Drilling Sub-Committee of the American Association of Oilwell Drilling are reviewed. Among the information presented are the number of operators using slim holes, the depths drilled to, optimum hole sizes, and problems and limitations of slim holes. G. D. F.

792. Drilling fluids: a current review. 3. The mud programme. G. K. Jones. *Petroleum, Lond.*, 1961, **24**, 53.—It is shown that careful choice and control of the drilling fluid can lead to a considerable saving in total cost of a completion. Reactive constituents in the rocks may lead to deterioration in mud quality, and geothermal gradients may also be important. A table gives the properties and compositions of special drilling fluids used to overcome various hazards. Finally, the practical consequences of the various requirements are considered by means of a summary of current techniques in the U.S.A., Canada, Venezuela, Trinidad, and the Middle East. G. D. F.

PRODUCTION

793. Production research must increase profitability in the '60's. L. E. Elkins. *Petrol. Engr*, Jan 1961, **33** (1), B30.—Production research seeks to develop new and improved techniques for current application and to initiate and evaluate long-range concepts. In exploration and production, the objectives of research should be to reduce the cost of drilling and development, reduce the cost of lifting and handling the oil, and to improve productivity and efficiency of recovery. Some past achievements in these fields are given, and a list of specific objectives (long-range and immediate) is proposed for future work. G. D. F.

794. Improving oil recovery. 1. P. D. Torrey. *Prod. Mon.*, Dec 1960, **24** (13), 10–19.—In the introductory lecture to a course for Texas Univ students, the principles, history, and importance of fluid injection are reviewed. G. B.

795. Phase behaviour in low pressure reservoirs. A. J. W. Headlee. *Prod. Mon.*, Oct 1960, **24** (10), 32–3.—A secondary recovery process is described which gives high total recovery at a high production rate. Natural gas is separated into three fractions, namely, methane, heavier gases, and liq. The heavy gas is injected over several months into the reservoir, where it displaces methane and dissolves in the oil, reducing its visc and increasing the vol. The liq fraction, saturated with gas at 200 psi, is then injected for several months and followed by a further injection of the gas. The whole is then displaced to the producing wells by methane and water.
G. B.

796. A programme to reduce sucker rod failure. O. C. Atkinson. *Prod. Mon.*, Oct 1960, **24** (10), 34–6.—Sucker rod failure in Kansas was greatly reduced by the use of corrosion inhibitors, extra care in assembly, the use of steels which had proved best in comparative tests in that service, and restriction of the stress to 20,000 psi. G. B.

797. Calculation of relative-permeability data. C. D. Stahl. *Prod. Mon.*, Dec 1960, **24** (12), 14–15.—The Burdine method of calculating relative permeabilities from capillary pressure data is explained. G. B.

798. Modelling technique for throughput rate calculations of injection operations. J. L. Reeves. *Prod. Mon.*, Dec 1960, **24** (12), 2–9.—A sheet of paper impregnated with carbon and cut to the shape of the reservoir is fitted with electrodes to represent the injection and producing wells. The electrical resistance between the electrodes is analogous to the reservoir resistance between wells, and the current flow gives directly the throughput for a system with a mobility ratio of one and a const permeability–thickness product. The use of the model to assist in calculations on a non-uniform system is described.
G. B.

799. A correlation of interstitial water saturation and heterogeneous wettability. E. N. Iwankow. *Prod. Mon.*, Dec 1960, **24** (12), 18–26.—Two portions of silica sand of uniform grain size were treated to make them oil-wet and water-wet respectively. Samples were prepared which contained various proportions of the two types randomly distributed. By saturating the samples with water and displacing this with core test fluid, the pore vol and the interstitial water saturation were determined. A correlation between the latter value and the wettability was derived by means of the normal distribution eqn. G. B.

800. Water quality control for subsurface injection. C. C. Wright. *Prod. Mon.*, Dec 1960, **24** (12), 30–4.—The filter test for solids likely to plug the formation and tests for corrosivity are described and their interpretation is discussed. By plotting the results of tests at regular intervals, warning is obtained of gradual deterioration in the quality of the water.
G. B.

801. Counterbalance can be determined from dynamic, unbalanced, and friction loads. J. R. Norton. *Petrol. Engr*, Feb 1961, **33** (2), B80.—The proper amount of counterbalance is shown to be very important in rod pumping. The counterbalance required is determined by the dynamic load, the unbalanced static load, and the friction load. An equation is obtained for the counterbalance weight, and the use of this equation is illustrated by means of a sample calculation.
G. D. F.

802. Glass pipes used to study vertical flow of air/oil mixtures. R. L. Rough and G. E. Rennick. *Prod. Mon.*, Dec 1960, **24** (13), 22–5.—A glass model for the study of air lift is described. Oil is lifted by compressed air to a max height of 65 ft. The assembly consists of eight model well bores with flow pipes of from 0·125 to 1 inch id with a 90° bend at the top. Flow rates and temp are controlled and measured. G. B.

803. Use of a graded viscosity zone to reduce fingering in miscible phase displacements. R. L. Slobod and S. J. Lestz. *Prod. Mon.*, Oct 1960, **24** (10), 12–19.—Lab studies are reported which show that fingering is reduced by a zone of graded visc between the oil in place and the displacing liq. Mixing which occurs in a reservoir may produce such a zone and reduce fingering in parts of the field far from the injection well. The illustrations have been printed, in error, on pp. 20–31. G. B.

804. Where are we going with miscible displacement? A. B. Dyes. *Petrol. Engr*, Feb 1961, **33** (2), B19.—Some 40–50 projects utilizing miscible displacement as an oil recovery process are in operation. The author has studied 13 of these, of which seven have been successful. The reasons for the failure of the rest are examined. The present state of the process shows that three methods are in use, and these are described. Cost factors are considered. The addition of water to the injected gas stream is shown to have beneficial results. Various future improvements are considered.
G. D. F.

805. Pressure maintenance by water injection at Parentis. (In French.) H. Meunier. *Rev. Inst. franç. Pétrole*, 1960, **15**, 1759–67.—The Parentis structure, 10 km by 4 km, has a productive area of 2500 ha and a 350-m oil zone in a limestone–dolomite sequence. The initial pressure was 225–7 kg/cm² at −2200 m, the saturation pressure being only 20 kg/cm² at 90° C, giving a GOR of 8 m³/m³. 29 producers have been drilled. There is good communication in a fractured dolomitic zone. By Jan 1957 the pressure had dropped 18 kg/cm² for an output of *ca* 2×10^6 m³ of oil. 79×10^6 m³ of oil out of 89×10^6 m³ in place is in the R3 zone, where the lower fractured zone has 50×10^6 m³. 50% recovery is estimated for this zone; a 1% recovery is given for the low-permeability upper part of the R3. At the beginning of 1960 output totalled 6,014,000 m³. The water drive has given a water rise of *ca* 10 m/pa. Water rises in the fractures, displacing oil fairly well from the water-wet blocks of matrix. In the tight calcareous zones production is by oil expansion.

The well-head pressures have dropped, and pressure maintenance seemed necessary to maintain flowing wells.

Drilling suggested that bottom-water drive is likely to be limited. Injection tests were made after acidization, and several marginal injection wells were drilled. To maintain pressure at 205 kg/cm² injection was expected to rise from 1700 m³/day in 1958 to 3750 m³/day in 1968, for oil production of 3600 m³/day. There appear to be irregular communications via the dolomitic zones between the Jurassic and the Cretaceous. Fresh water is injected without the formation of precipitates.

An electric analyser study has been carried out by dividing the field into a number of units for which injection rates have been determined to ensure even water rise. G. D. H.

806. Optimum number and output of producing wells. (In French.) A. Chueca and B. Seve. *Rev. Inst. franç. Pétrole*, 1960, **15**, 1741–50.—Production may be by expansion of a single hydrocarbon phase, by imbibition, by gravity drainage, or by non-capillary displacement (gas-cap expansion, water drive). Slow production favours the effectiveness of water drive and expulsion by water imbibition. If gravity drainage is effective it can enhance the recovery by dissolved gas and gas-cap drives. Oil expansion gives only *ca* 10% recovery; good water drive can give 60%. For low rates of flow final recovery is believed to be independent of the rate; above a critical rate recovery begins to fall off, although it is difficult to define this rate.

Spacing may affect recovery by virtue of the areal sweep

efficiency, but it is difficult to apply model and theoretical studies on this point. Both placing and spacing are important. Economics is important in deciding on the optimum number of wells. A company may have to decide between vigorous development of one field or spreading the effort over a number of fields, for the available investment is limited. Borrowing or self-financing may be involved. The investments may be spread; the income will be spread over a period. Expenses will be of several types. The life of the field must be determined; this involves the decline law. Dissolved gas drive may give hyperbolic decline; bottom-water drive may give exponential or linear declines according to the assumptions made.

Example calculations based on the principles discussed are summarized, and an appendix gives basic relationships. The optimum number of wells did not vary widely with changes in the assumptions; the rate of interest has a marked effect. Depletion allowances will affect the position. G. D. H.

807. Estimating oil reserves from production data. W. F. Stevens and G. Thodos. *Petrol Engr*, Feb 1961, **33** (2), B46.—The paper shows the possibility of estimating oil reserves by means of extrapolating production decline curves. Three types of such curves commonly arise—constant percentage decline, hyperbolic decline, and harmonic decline. Equations are set up for each of these cases to give the total cumulative production at the time of abandonment. A worked field example is provided. G. D. F.

808. New method simplifies predicting water flood performance. H. C. Slider. *Petrol. Engr*, Feb 1961, **33** (2), B68.—The various factors which are of importance in predicting the rates of recovery by water flooding are listed; the present paper considers the effects of permeability variation, oil bank build-up, and mobility variation. The other factors are thought to be less important. Equations are derived for calculating the distribution of injected water, the advance of the oil and water fronts, the producing rates, and the fractional recovery. Finally, a sample calculation is provided. G. D. F.

809. Modern well completion series. Pt 10A. Permanent type, multiple, and tubingless completions. T. A. Huber and C. B. Corley, Jr. *Petrol. Engr*, Feb 1961, **33** (2), B34.—The development of permanent type completion techniques is dealt with briefly. Wireline operations and well installations for various requirements are considered. Methods of low-pressure squeeze cementing, sand removal, and sand control by consolidating plastics are dealt with. The paper concludes by considering pulling units operations, concentric tubing workovers, and the use of dump-bailers for placing cement. G. D. F.

810. Bacteria in flood water. J. M. Sharpley. *Petrol. Engr*, Feb 1961, **33** (2), B55.—Bacteria in water used for water flooding can block filters and formation pores and cause severe corrosion problems. It is therefore necessary sometimes to obtain microbiological data on such water; various sources of error in obtaining such data are outlined. The effect of bacteria on formation permeability is mentioned under several headings. The bacteria commonly referred to as "iron bacteria" and "slime-forming bacteria" are discussed, and mention is made of certain beneficial treatments. G. D. F.

811. What's ahead in oil recovery? P. B. Crawford. *Petrol. Engr*, Jan 1961, **33** (1), B24.—For the first 90 years after Drake, only water flooding and gas injection were used to assist oil recovery. Since *ca* 1950 many new recovery processes have been proposed, many of which are as yet unproven. This paper discusses several of these, and shows the necessity of having several recovery processes and the current difficulties in choosing the most suitable for a given situation. Among the processes dealt with are fire-flooding (forward and reverse combustion), miscible displacement (high-pressure gas drives, enriched gas drive, propane slug process, alcohol floods, CO_2 in water), atomic explosions, improved water flooding, and the use of bacteria. The possibilities of steam injection and the use of chemical additives in water flooding are also mentioned briefly. G. D. F.

OILFIELD DEVELOPMENT

812. Drilling rise due in free world outside U.S.A.–Canada. Anon. *World Oil*, 15.2.61, **152** (3), 108.—Drilling outside the U.S.A. and Canada in the free world in 1961 is expected to increase by *ca* 7% to over 6000 completions. 6081 new wells are forecast, compared to 5702 in 1960, and *ca* 1300 are planned for 1961. Drilling decline in Venezuela will continue, but at a slower rate, and slightly fewer completions are expected in the Middle East. Drilling in Africa should expand with the development of fields, particularly in Libya, but in the Far East drilling rates should remain about the same. A table shows 1961 drilling prospects for the free world outside the U.S.A. and Canada. C. A. F.

813. World crude production to climb again in 1961. Anon. *World Oil*, 15.2.61, **152** (3), 111.—World crude production in 1961 is expected to exceed 22 million bd, *ca* 5·5% more than in 1960 and maintaining about the same rate of growth. Production in the U.S.A. should increase by *ca* 2·7% and outside the U.S.A. by *ca* 7%. U.S. contribution to the world total will fall from *ca* 33·6% in 1960 to *ca* 32·7% in 1961. Oil production in Russia in 1960 is estimated at 2·9 million bd, 15·1% more than in 1959. Significant gains are reported from the Hassi Messaoud field and the Polignac Basin fields of Algeria–Sahara, and crude supplies from the Middle East continue to rise despite new output from N Africa. C. A. F.

814. 1960 demand 21,590,000 bd. Anon. *World Petrol.*, Jan 1961, **32** (1), 41.—World oil consumption in 1960 increased by 6·4% from 1959 to 21,590,000 bd approx. The previous annual rise was 6·9%, and there is a continuous trend of increasingly higher demand in the E compared to the W Hemisphere. A 5·8% increase is estimated for 1961, the fall being due to a lower anticipated market in the W, where demand should increase by 2·8% compared to 8·9% in the E. Tables show world consumption and demand for crude oil and refined products by countries and areas for 1960 and 1961. C. A. F.

815. World crude production up 7·3% in 1960. Anon. *World Petrol.*, Jan 1961, **32** (1), 40.—World crude oil production increased by *ca* 7·3% in 1960; from 19,528,010 bd in 1959 to 20,954,736 bd in 1960. A marked increase is also expected for 1961. The U.S.A. continued to decline compared to the rest of the world, producing almost one-third of the world's total. The U.S.S.R. is now the second largest producing country, having displaced Venezuela, which ranks third; an annual rise in demand of *ca* 14% is estimated in the U.S.S.R., and production is expected to increase rapidly. The two main areas of greatest relative increase were Argentina (from 122,418 bd in 1959 to *ca* 160,274 bd in 1960) and the Sahara, where 200,000 bd were being produced by the end of 1960. Production will start in Libya in 1961. A table shows world crude oil production by countries for the whole world for 1959 and 1960. C. A. F.

816. Liquid hydrocarbon reserves in U.S.A. are at new high. Anon. *World Oil*, 15.2.61, **152** (3), 100.—Although drilling has declined in the U.S.A. since the 1956 peak, there has been successful discovery of new oil reserves, and the ratio of reserves to annual production has been well maintained; at the end of 1959 the ratio was 13·3 years, slightly above the average of 13·1 years for the period 1947 through 1959. At the end of

1959 U.S. reserves of liq hydrocarbons reached a new peak of 38,241,655,000 brl, 1·5 billion brl more than the previous year. 47·8% of these reserves are held by Texas, 15·7% by Louisiana, and 10·7% by California. Tables give estimated proved reserves of crude oil, natural gas liq, and total liq hydrocarbons in the U.S.A., by states, at end of 1958 and 1959, and crude reserves by years since 1945. C. A. F.

817. Survey of proved reserves. Anon. *Oil Gas J.*, 30.1.61, **59** (5), 126–33.—The estimated remaining reserves of crude oil and condensate for the larger fields of the U.S.A. are presented alphabetically by states. A. D. S.

818. The outlook for U.S.A. petroleum demand—1961. V. B. Guthrie. *World Petrol.*, Jan 1961, **32** (1), 43.—Forecasts of oil demands in the U.S.A. are based on long-range trends such as continuing slow-down in the overall consumption rate in the U.S.A. and in its export trade, a growing demand for kerosine for jet fuels, and continued expansion in the petrochemical market. In 1961 total U.S.A. demand for oil products is expected to reach 10,098,000 bd, or 2·2% more than in 1960. Gasoline demand in 1961 will average 4,228,000 bd, approx 3% more than in 1960. After 1961 an average rate of gain in total requirements is estimated at *ca* 3% annually over the next few years. This compares with a total rate of gain of 15% since 1955. A table shows forecasts of 1961 petroleum product demands in the U.S.A. C. A. F.

819. Decrease in drilling foreseen for Western Canada in 1961. Anon. *World Oil*, 15.2.61, **152** (3), 106.—In spite of anticipated boom in export sales of natural gas in W Canada during the next few years, it is not expected that drilling activity will expand during 1961. *Ca* 2425 wells are expected to be drilled, 0·5% less than in 1960. Development is restricted by lack of a formal national oil policy for either voluntary or compulsory expansion of markets for Canadian crude. Well completion records in Canada have declined steadily in the past four years, 2993 in 1957 down to 2437 in 1960. Tables show forecast of wells and footage to be drilled in W Canada in 1961. C. A. F.

TRANSPORT AND STORAGE

820. Transportation costs. N. A. C. Pryce and C. D. Callieu. *Chem. & Ind.*, 1961, 45–6, 202–3.—Correspondence (*cf* Abs **279**, 1961). W. A. M.

821. The design and choice of oil-handling equipment. G. V. Bruckshaw. *Petrol. Times*, 24.2.61, **65**, 161–3.—Five basic considerations must be taken into account in considering new designs of oil-handling equipment. These are: reduction in excessive hose replacement costs, common in pre-war days; use of the jetty working area as economically as possible; demand for greater flow rates, with special emphasis on reducing pressure losses; the increase in tanker size and the need to reduce the labour force required at the marine terminal. Existing designs of oil-handling equipment for mounting on jetties are briefly discussed under four main groups, and factors which should condition a choice of system are enumerated. Finally, it is suggested that standardization on a world-wide basis should not present quite the enormous problem anticipated by shipbuilders, tanker companies, and marine terminal operators. A. D. S.

822. Supervisory radio control panel for Laurel product pipeline. L. Walter. *Petroleum, Lond.*, 1961, **24**, 93.—The whole of the Laurel pipeline system (447 miles from Philadelphia to Cleveland) is operated from a control room at the headquarters. By means of information received and sent out by a multi-channel, closed-circuit system of microwave radio, it is possible to route and deliver shipments by means of buttons on a graphic control panel. It is also possible to find the most economical combination of pumps and to keep on view the locations of all shipments at all times. Pumping stations and product storage are also described. G. D. F.

823. Submarine pipeline construction methods. 2. J. G. Bomba. *Petrol. Engr*, Feb 1961, **33** (2), D23.—This part continues the description of the Mississippi underwater pipeline commenced in pt 1, and passes on to a consideration of the design and execution of a gas pipeline under the Hudson River at New York. G. D. F.

824. Pipeline fundamentals: instrumentation, controls, and automation. 4. Telemetering. M. T. Nigh. *Petrol. Engr*, Jan 1961, **33** (1), D45.—The problem of sending a large number of signals from one locality over one tone channel is considered. Sending and receiving "distributors" are used, and the problem is simple theoretically. Difficulties arising in practice are considered. The paper passes on to the consideration of variable frequency telemetering, and the relative advantages of this system. G. D. F.

825. Sudden opening or closing of an outlet valve on a pipeline. G. Ransford. *La Houille Blanche*, 1960, **15**, 657–73.—Some aspects of unsteady flow in pipelines have been considered, in particular the effect of friction on "water-hammer" phenomena. Basic equations are set up describing the problem, and these are solved for certain cases by means of a digital computer. Graphs of the results are presented in terms of dimensionless parameters for the cases of sudden closing and sudden opening of a valve at the end of a pipeline under certain conditions. The graphs show pressure at the valve, variation in inflow at the far end, and variation in outflow. General conclusions are drawn from the results. G. D. F.

826. Direct solution for diameter of pipe in rough turbulent flow. N. Rajaratnam. *La Houille Blanche*, 1960, **15**, 714–19.—The problem being considered is the determination of the pipe dia required to carry a given volumetric flow rate of material when the flow is in the turbulent regime and the pipe is of a given roughness. A solution has been possible previously only by means of time-consuming trial-and-error calculations. This paper presents a direct analytical solution of the problem. The results are presented graphically and the method is made clear by means of a worked example. G. D. F.

827. The limits of applicability of the Hazen–Williams formula. M. H. Diskin. *La Houille Blanche*, 1960, **15**, 720–6.—It is shown that the availability of nomograms and the like based on the Hazen–Williams formula often leads to the use of this formula in pipe flow calculations outside its limits of application. The author derives the max and minimum Reynolds numbers for the applicability of this formula at different relative roughnesses of the pipe. These results are tabulated and also plotted for easy reference on an ordinary friction-factor chart of the Moody or Nikuradse type. G. D. F.

828. Italian pipeline and terminal developments. Anon. *Petroleum, Lond.*, 1961, **24**, 97.—Recent developments in Italy in the transportation of petroleum and products are dealt with briefly, notably the oil-port at Venice, the Ravenna submarine oil line, and the Cellino–Teramo gas line. G. D. F.

829. What new standards for 4½-inch API casing mean to users. J. A. Casner. *Oil Gas J.*, 16.1.61, **59** (3), 97–8.—The API pipe-standardization cttee has set up new standards for

4½-inch oil-well casing. The result will be to increase the length of the 4½-inch eight-round short thread length and to add a new wall thickness between 4½-inch od 9·50 lb and 4½-inch od 11·60 lb casing. The user can run mixed strings of 4½-inch od casing without using an excess number of cross-over joints. He will be warned against those cases where cross-over joints may now be required. Thus he can expect a safer, faster, and cheaper casing job. A. D. S.

REFINERY OPERATIONS

REFINERIES AND AUXILIARY REFINERY PLANT

830. How a computer is used to plan refinery operations. J. R. Jutras. *World Petrol.*, Jan 1961, **32** (1), 54.—An oil company has recently been planning short range operations of its six refineries in Canada by using linear programming and an IBM 650 electronic computer. Before 1956 the normal practice in planning refinery operations was to use the traditional case method, based on the judgments of experienced personnel. This became less efficient because of the increased complexity and freedom of choice created by new refinery facilities and the effects of seasonal variation in product demand. This need for improved planning was effectively met by the electronic computation techniques which have been found to handle the problem adequately. The linear programming can select, from available crude oils and many interrelated refinery unit operating modes and product blends, a combination which would meet given product demands at min cost.

The problem was formulated into four main steps: (1) analysis of refining operations to determine key product qualities, unit operating restrictions, and blending practices that limit flexibility of operations; (2) the erection of unit operating models representative of each unit's capability; (3) expression of results in linear mathematical form; and (4) acquisition of variable cost data. In practice, the technique has proved very successful. Six refs. C. A. F.

831. Automatic blending lives up to goal. B. B. Butler. *Petrol. Refin.*, Aug 1960, **39** (8), 97–100.—Results are reported of an automatic gasoline blending system. The automatic process results in the saving of blending tanks, better quality control, and faster and more flexible bending. M. J. M.

832. Metal inspection methods. G. G. Mainland and J. Storrar. *Oil in Canada*, 24.10.60, **12** (52), 30–8.—Methods and instruments for non-destructive testing are reviewed. G. B.

833. Outlook for refining in Europe. R. André. *Petrol. Engr*, Jan 1961, **33** (1), C32.—At the beginning of 1960, refinery capacity in W Europe stood at 193 million metric tons pa (MMT), or 40% of that of the U.S.A. It is expected to reach *ca* 280 MMT by 1963. The rapid growth of demand is outlined. The structure of the markets is contrasted with that of the U.S.A. and shown to be very different. Refinery distribution is dealt with, and Britain is shown to lead at present with a capacity of 47 MMT, followed by France, Germany, and Italy. Previously the great refining complexes were near the coast, but the construction of pipelines inland is changing this picture. Petrochemical developments are reviewed. G. D. F.

834. Sizing of vapour relieving systems. J. Conison. *Petroleum, Lond.*, 1961, **24**, 57.—The factors to be considered in the sizing of vapour relieving systems are outlined. The considerations start with the codes in use (in the U.S.A.) for pressure vessels. The characteristics of various types of relief valves are discussed, and equations are derived for calculating the vapour relieving capacities of the relief valves. Calculations for safety designing the header and lateral lines are given. G. D. F.

835. Austria's Schwechat refinery. R. Sobotka. *Petroleum, Lond.*, 1961, **24**, 61.—The Oesterreichische Mineraloelverwaltungs AG (OeMV), which produces 95% of the Austrian crude, has constructed a new refinery (32,000 bd) at Schwechat to replace its old plants. A large part of the output is sold within a radius of 120 miles of the refinery. The refinery was designed by the Lurgi GmbH, and the various firms participating are mentioned. Feedstock consists of Austrian and Soviet crudes. The products, services, etc., are mentioned in some detail. G. D. F.

836. BP's new Ruhr refinery now on stream at Dinslaken. Anon. *World Petrol.*, Jan 1961, **32** (1), 48.—A new 100,000-bd refinery has been commissioned near Dinslaken in the Ruhr. In the first stage are two crude dist units, a 10,000-bd cat reformer, a hydroformer, and copper chloride treatment units. Crude is supplied by a 28-inch pipeline from Wilhelmshaven to Wesseling near Cologne. This runs for 200 miles and has a present capacity of *ca* 9 million tons pa, which will be increased later to 22 million tons pa. Products from the refinery will include top grade motor gasolines, aviation turbine fuels, marine diesel oils, gas and fuel oils, LPG, and petrochemical bases. C. A. F.

837. Slagen: Norway's first major refinery. Anon. *Petroleum, Lond.*, 1961, **24**, 99.—The 2 million tons pa refinery of the A/S Esso-Raffineriet, Norge, which is the largest refinery in Scandinavia, came into operation at Slagen, Norway, in Dec 1960. Unusual features of the refinery are discussed, together with loading and storage facilities. G. D. F.

DISTILLATION

838. Figure distillation this new way. W. N. Lyster *et al.* *Petrol. Refin.*, Aug 1960, **39** (8), 121–6.—The optimum operating point for a dist column is solved by a convergence method using a digital computer. Equations are first derived for total reflux in the rectifying section and total reboil in the stripping section. Working between these two limits, the optimum operating point is obtained from an examination of the dist and bottoms compositions. A sample calculation is included in the article. M. J. M.

839. The Kuwait bulk LPG project. C. I. Kelly. *Petrol. Times*, 10.2.61, **65**, 130–1.—The Kuwait Oil Co's LPG plant now being constructed will facilitate the production of *ca* 200,000 tons pa of commercial grades of liquefied propane and butane. Low pressure gas, rich in propane and butane, will be fed to this plant from three gathering centres and after compression and cooling will be fractionated to provide the liq propane and butane. These liq under pressure will be freed from H_2S and mercaptans with a 10% soda soln and after gravity separation will be dehydrated and refrigerated. The storage facilities will consist of two spherical tanks, 90 ft in dia, each capable of holding 65,000 brl of LPG. A third vessel will be an insulated, double-walled cylindrical, 100-ft high, dome-roofed tank and is designed to store 100,000 brl of either liq propane or butane at atm pressure and −50° F. Ship loading facilities will allow either chilled LPG under pressure or fully refrigerated LPG, propane, or butane, to be loaded into LPG tankers. A. D. S.

ABSORPTION AND ADSORPTION

840. Largest U.S. gas-processing plant now in operation. Anon. *Oil Gas J.*, 13.2.61, **59** (7), 78–9.—Humble Oil and Refining Co's new gas plant in Texas is designed to produce 950 MMcfd of gas. This plant is the focal point of a vast gathering system in which gas is collected through 170 miles of lines from 13 production fields scattered over a wide area of SW Texas. Three significant factors were considered in the decision to build this unit—increasing demand for industrial fuel, growth of petrochemical industry, and the economic utilization of gas reserves. At present the plant is processing *ca* 545 MMcfd of gas, and later in 1961 it will be increased to around 680 and soon after to 800 MMcfd. The plant processing scheme is conventional, liq being removed from the rich gas by oil absorption, followed by stripping at a later stage. A. D. S.

841. New gas treating process. Anon. *Petrol. Times*, 10.2.61, **65**, 137.—The Stretford process is capable of reducing the hydrogen sulphide content of gases to below 0·1 ppm. It is a continuous chemical absorption process, operated at ambient temp and under any reasonable pressure. The absorbing agent is an aq soln of reagents produced during the manufacture of anthraquinone dyestuffs, which on regeneration by air blowing yields the original reagents together with elemental sulphur. The sulphur is free from arsenic or iron oxide and can be worked up to yield a product of 99·9% purity.

It is anticipated that this process will be profitably applied in the sweetening of natural and casinghead gases, refinery tail gas, low boiling liq hydrocarbon products of the petroleum industry, synthesis gas, and also polluted effluent gas streams from industrial plants. A. D. S.

SOLVENT EXTRACTION AND DEWAXING

842. Dephenolizing tar oils with lactic acid. (In German.) G. Kowalski and B. Los. *BrennstChemie*, 1959, **40**, 198–201.—The high solubility of lactic acid for phenols is utilized for dephenolizing tar oils. Solvent power for carbolic acid, aromatics, and paraffinic oils is determined for characterizing the properties of 5–50% lactic acid in temp range 20°–45° C. Extraction investigations with carbolic oil from coke plant-tar show that acid concn *ca* 25% upwards are suitable for the dephenolizing. Considerable improvement in the reaction trend can be attained by paraffinic hydrocarbon addition. Seven refs. R. T.

843. Purification of phenol-containing waste waters by the ash–air-process. III. Estimation of adsorption and oxidation effect of ashes and coal dusts in purifying phenol-containing waste waters under air treatment. (In German.) A. Rieche, H. Seeboth, and H. Seyfarth. *BrennstChemie*, 1959, **40**, 194–8.—In phenolic waste water purification by the ash–air process or by absorptive purification, ashes and coal dust behave very differently. Phenol pptn follows partly by adsorption, partly through their becoming insol by oxidn. Difficulty oxidizable phenols, as the monovalent and resorein, are adsorbed as multivalent on activated dusts. They can be ppted also oxidatively, so insol, and incapable of lixiviation, if treated with ash and air in presence of an easily oxidizable phenol. One mol bivalent phenol requires two mol O_2. In phenol pptn by pure oxidn, namely, in ash–air treatment, O_2 requirement proceeds parallel with phenol disappearance from the soln. With coal dust and air O_2 consumption is less than corresponds to phenol disappearance, this according to dust nature. Their dephenolizing effect rests partly on adsorption and partly on air oxidative pptn. Dephenolization of low-temp-carbonization waste water by the ash–air process can take place, with suitable ashes in *ca* neutral soln, if worked warm. Here oxidn cat of the ash participate. Thereby alkali cont of ashes—on account of the buffer effect of the fatty acids—plays a lesser role than with phenolic model soln. 14 refs. R. T.

CRACKING

844. Upgrading catalytic cracker feeds. P. W. Sherwood. *Petroleum, Lond.*, 1961, **24**, 101.—The reasons for processing cat cracker feedstocks are outlined: to obtain more gasoline, less coke, fuel oil, etc; to improve quality of cracked product; to improve cat cracker operation. The undesirable constituents in feedstocks are listed. The two general lines taken by feedstock treatment—the improvement of propane deasphalting processes and hydrogenative treatment—are dealt with in some detail. G. D. F.

CHEMICAL AND PHYSICAL REFINING

845. The effect of surface tension phenomena on mass transfer. F. J. Zuiderweg. *Ingenieur,'s Grav.*, 13.1.61, **73** (2), Ch1.—The performance of contacting equipment used for dist, adsorption, and extraction processes depends partly on the type and extent of the interfacial area of the components being contacted. This is in turn governed by surface tension phenomena, and experimental work has shown that if two miscible components are contacted the rate of mass transfer can be altered by bringing about sudden changes in the interfacial tension. This is known as the Maragnoni effect. The stability of liq films is considered for liq/vapour systems in the performance of Vigreux columns and grid trays. Foam stability in liq/vapour systems, and emulsion stability of liq/liq systems are also discussed. 13 illustrations and diagrams are included. D. C. E. de W.

SPECIAL PROCESSES

846. Reaction kinetics of the Shell air-solutizer sweetening process. H. Groothuis. *Chem. Engng Sci.*, 1961, **14**, 176–81.—The reaction kinetics of the Shell air-solutizer sweetening process have been investigated theoretically and experimentally (on a small scale). In the experiments (which are fully described and discussed) the hydrocarbon feed rate was kept constant, and the effects of initial concn of mercaptans and oxygen, temp, and rate of stirring were studied. It is found that the oxygen transfer limits the overall reaction rate considerably. Increased reaction rates may be attained by increasing the stirring rate, but power requirements rise steeply and there is danger of entrainment of the solutizer droplets in the treated product. G. D. F.

847. Ferrofining—new process for lube oils. H. F. Dare and J. Demeester. *Petrol. Refin.*, Nov 1960, **39** (11), 251–3.—Ferrofining is a new process for the hydrotreatment of lub oils. The cat, which has an expected life of two years, is able to treat straight dist lubricants, eliminating any acid and clay treatment normally required.

Ferrofined oils are of superior quality to those processed by conventional methods. For a 31,000-bsd ferrofining plant the estimated capital cost is $495,000, while the operating cost including depreciation is estimated at 19·7 c/brl. M. J. M.

848. Maybe aromatics production is your dish. L. D. Stewart, R. A. Lush, and J. H. Miller. *Oil Gas J.*, 6.2.61, **59** (6), 110–13.—DX Sunray diverted excess capacity of a new cat reformer to aromatics production. A Udex extraction unit was installed and, together with offsite tankage, yard piping, loading, and other facilities, cost $2 million with a calculated payout of under two years.

The production of high-purity, low-boiling aromatics from petroleum is carried out in three steps. Pre-fractionation to

concentrate the naphthenes in the fuel, conversion of hydrocarbons to aromatics, and separation and purification of the aromatics. A flow diagram of the process is presented, together with full process details. A. D. S.

849. Metallo-organic compounds in petrochemistry. (In German.) K. Ziegler. *BrennstChemie*, 1959, **40**, 209–14.—A new synthesis of Al-alkyls from Al, H_2, and olefins, use of Al-alkyls as cat and as true reaction intermediate products are discussed. Al-alkyls themselves polymerize olefins to the different products in the low-mol range. In combination with definite heavy metal cpds they form the highly effective metallo-org mixed cat with which quite new results can be produced in the sphere of low- and especially high-mol polymers. Al-alkyls are important as intermediate products for synthesis of higher fatty alcohols from C_2H_4, and for many further transformations. Further, Al-alkyls play an important role as auxiliaries for the newly reported electrolytic synthesis of TEL. 41 refs. R. T.

METERING AND CONTROL

850. Process chromatograph controls de-ethanizer operation. J. Zike. *Oil Gas J.*, 13.2.61, **59** (7), 92–4.—A process chromatograph has been controlling ethane content of the de-ethanizer bottom product at Reef Corpn's Texas plant for more than a year. The chromatograph is located in the temp control loop which varies heat to the reboiler. A sample is taken ahead of the liq-level control valve on the bottoms out of the de-ethanizer and the % ethane is recorded. The relationship of ethane content to the controller's set point then positions the temp recorder-controller (TRC) pneumatically to compensate for drift. The TRC resets the flow indicator-controller, which in turn adjusts the steam flow by operating a flow control valve on the steam condensate out of the reboiler.

Since this instrument was installed, an average propane vapour pressure of 209·5 psi has been produced with a max and min. of 207 and 214 psi respectively. It is estimated that the equipment paid out in six months. A. D. S.

851. How a computer helps Atlantic get the most out of butane. J. R. Alcher, P. D. Birkhahn, and H. C. Lester. *Oil Gas J.*, 16.1.61, **59** (3), 72–5.—Atlantic Refining Co has developed a programme for handling refinery butanes. It includes the effects of process variables, inventories, and gasoline specifications on butane excesses and requirements and alkylate production. It can be used to evaluate periodically actual plant operation; to give short-term predictions to serve as operating guides, yearly forecasts to determine both excesses available for sale and purchase requirements, and long-range forecasts for planning purposes; and to determine the effect of butane usage on the capital cost of plant equipment.

Two cases are calculated for a hypothetical but typical refinery, and these show the type of results which can be obtained from the programme. A. D. S.

PRODUCTS

CHEMISTRY AND PHYSICS

852. Compressibility factors for super pressures and temperatures. J. M. Lenoir. *Petrol. Refin.*, Aug 1960, **39** (8), 135–8.—Charts are presented for obtaining compressibility factors of values greater than 1; the data were obtained from PVT measurements of some common gases. The compressibility factors for hydrogen and the rare gases do not fit the conventional charts. In the latter case the compressibility factor can be obtained from the conventional charts using fictitious critical constants. The critical constants are given in a chart as a function of temp. The author claims the prediction accuracy for pure gas average 4% of measured values. M. J. M.

853. Effect of dissolved oxygen and the spin-lattice relaxation time of free radicals in petroleum oils. A. J. Saraceno and N. D. Coggleshall. *J. Chem. Phys.*, 1961, **34**, 260–3.—It is found that the degree of saturation of free radicals in petroleum oils varies with the manner of treating the oils before examination. Here the effects of solvents, dissolved oxygen, and radiation (visible and uv) on the spin-lattice relaxation time T_1 were investigated. It is shown that changes in T_1 due to the effects of these factors can all be traced to the overriding effect of dissolved oxygen, giving an "apparent" increase in T_1, which can be reversed by stripping the dissolved oxygen. The true free radical content remained unchanged by the processes studied. G. D. F.

854. Solubility of methane in water. D. S. Davis. *Industr. Chem.*, 1961, **37**, 117.—Nomograph gives solubility of CH_4 in H_2O (0·03–0·5 mol %) from temp (50°–100° F) and pressure (100–12,000 psi). Temp scale is doubled with concn scale (0·2–0·5 mol %) which indicates min temp at which chart is valid for each concn, because of hydrate formation at lower temp. W. A. M.

855. New way to get relative volatilities. O. H. Hariu. *Petrol. Refin.*, Aug 1960, **39** (8), 129–32.—The relative volatilities for pairs of hydrocarbons may be predicted knowing the normal bp of the materials. The method is dependent upon the straight line relations depicted in a Cox-type vapour pressure chart; the theory of the method is given. Previous correlations have been reviewed and are compared with the new method. Results of the Cox chart equation were compared with API 44 and Esso 51.12 vapour pressure data. M. J. M.

ANALYSIS AND TESTING

856. Test procedures for compounds used as preservatives in industrial coolants. L. J. Brandeberry and H. V. Myers. *Lubric. Engng*, 1960, **16**, 161–3, 170.—Problems arising from the bacterial contamination of cutting oils are briefly reviewed and methods of screening potential anti-bacterial agents are illustrated by tests using tris (hydroxymethyl) nitromethane. Procedures for total plate count, coliform bacteria count, and plant tests are described, and the mode of functioning of the anti-bacterial agent employed is indicated. Ten refs. J. G. H.

857. Rapid determination of heat capacity of liquids over extended temperature ranges. J. W. Barger *et al.* *Lubric. Engng*, 1960, **16**, 105–7, 118.—Removal of heat from bearing surfaces is a function of the lubricant calling for accurate knowledge of its heat capacity and thermal conductivity. Design and operation of a simple semi-adiabatic calorimeter permitting rapid and accurate determination of these properties is described. J. G. H.

858. Error sources of the calorific value determination. (In German.) N. Getoff and L. Mackowski. *BrennstChemie*, 1959, **40**, 186–9.—Among errors in cal val estimation are incomplete combustion of solid and liq fuels. Heat exchange between calorimeter and surroundings plays a large part. Sample preparation by different lab is important, likewise analytical procedure. To obtain complete combustion of

ballast-rich fuels, an approved form of ignition wire is given. Importance of sp change of calorimeter action on cal val estimation is discussed. Const jacket temp is recommended. Nine refs. R. T.

CRUDE OIL

859. Size and shape of asphaltic particles in petroleum. P. A. Witherspoon and Z. A. Munir. *Prod. Mon.*, Oct 1960, **24** (10), 20–31.—Asphaltic particles have been separated from a wide variety of crude oils by centrifuging at 80,000 G. From the rate of sedimentation in the centrifuge, determined by photography with transmitted light, and from electron microscope studies and visc measurements in benzene, the particle size is calculated to be 30–65 A, corresponding to mol wt of 10,000–100,000, and the shape is believed to be spherical. The theory of sedimentation in the ultracentrifuge is discussed. The illustrations have been printed, in error, on pp. 14–18. A bibliography of 30 refs is given. G. B.

GAS

860. Natural gas processing in Canada. J. G. Stabback. *Petrol. Engr*, Jan 1961, **33** (1), C24.—A large table gives the location, owners, types of plant, capacity, and products of gas processing plants so far installed in Canada. The total capacity (end of 1960) is *ca* 1930 MMcf/day (residue gas basis). The development of gas processing in Canada is traced briefly. Plants to be constructed in 1961 are listed and predictions are made as to future developments. G. D. F.

861. Rimbey gas plant, Canada's largest, displays interesting design features. Staff of Poole-Pritchard Canadian Ltd and The British American Oil Co. Ltd. *Oil in Canada*, 10.10.60, **12** (50), 32–6.—The plant described has a feed capacity of 326,000,000 cu ft/day. Features include the use of centrifugal propane pumps for refrigeration, the steam and electric power facilities, and the use of air coolers instead of water. G. B.

ENGINE FUELS

862. Kinetics of slow oxidation of hydrocarbons in the gas phase and relationships between slow oxidation and motor combustion. (In German.) E. Terres *et al.* *BrennstChemie*, 1959, **40**, 177–86.—Processes in the IC combustion motor are clarified for a large number of hydrocarbons, *n*-paraffins, *iso*paraffins, and some olefins, at different temp. Induction times receive especial attention in pressure–time curves. As comparative ref magnitudes temp at the same reaction velocity are taken for a series of paraffins, aromatics, and naphthenes. Results indicate relationship between oxidizability of pure hydrocarbon components and their behaviour in the IC motor. From the linear relationship of two estimation magnitudes, obtained in very different ways, oxidn rate and crit CR ratio, it is concluded that slow oxidn and combustion in the IC motor follow the same chain reactions. Knock limit is characterized by an excellent combustion rate. Oxidn rate and knock-resistance are dependent on hydrocarbon structure, side chain length, and branching degree. 12 refs. R. T.

GAS OIL AND FUEL OIL

863. Fuel oil flow control for open hearth furnace. Anon. *Fluid Handl.*, 1960, 16.—Description with diagram of computer-operated fuel oil flow control for open hearth steel furnace, with provision for firing the furnace alternately from either end, the fuel oil flow being automatically controlled during reversing. W. A. M.

864. Acid deposition in oil-fired boilers: comparative trials of additives and testing techniques. P. A. Alexander *et al.* *J. Inst. Fuel*, 1960, **34**, 53–72.—Two power stations, each burning residual fuel containing between 2·9 and 4·6% sulphur, were selected for comparative trials of solid additives intended to suppress acid deposition. The effectiveness of the additives was assessed in three ways—by analysis of the flue gas and by tests with the dewpoint meter, deposition, and corrosion probe; by observing the effects on boiler operation; and by examining the boiler heating surfaces and air-heater deposits at the conclusion of each trial. Magnesium carbonate, a proprietary additive, and zinc dust were examined, and all greatly reduced the amount of sulphuric acid in the flue gas at the air-heater inlet and outlet. Of these additives, magnesium carbonate was cheapest (8*d*/ton fuel), the proprietary additive (10*d*/ton fuel) caused greatest fouling of the air-heater, and zinc (1*s* 7*d*/ton fuel) fouled the burner-air ports, interfering with combustion. Dual firing (coal : oil ratio 1 : 10) and pulverized-fuel-ash injection caused severe fouling of the air-heater by ash and sulphuric acid.

The most effective way of assessing the harmful nature of the flue gas was to measure chemically the rate of deposition of acid on a probe cooled to air-heater metal temp. The electrical dewpoint, except early during a trial of zinc injection, showed no correlation with other measurements of the acid-depositing tendencies of the gas. A. D. S.

LUBRICANTS

865. Survey of lubrication methods. 1. Characteristics of lubricating methods. 2. Lubrication categories. 3. Compendium of lubricating devices. A. F. Brewer. *Lubric. Engng*, 1960, **16**, 102–4, 128; 153–6; 206–9, 271–3, 312–14, 519–22.—Importance of lubricant delivery, reliability, cost, and design considerations in lubrication systems are briefly discussed.

In part 2 basic characteristics of main lubricating methods are briefly discussed under the following heads: manual devices, drop feed devices, splash or bath lubrication, ring, chain, and collar oilers, pad and waste type devices, positive force feed lubricators, air–oil devices, pressure circulating systems, centralized lubrication systems, and built-in lubrications.

In part 3 the simplest forms of lubricating devices, cans and grease cups, are described and illustrated, followed by splash and pad systems, mechanical feeds, oiled air lubricators, spray valves, pressure circulating systems, and centralized installations. J. G. H.

866. Relaxation phenomena in lubrication. E. O. Forster. *Lubric. Engng*, 1960, **16**, 523–8.—The origin of viscoelastic characteristics in lubricants is briefly discussed, their variation with composition is indicated, methods of measurement are described, and possible applications in increasing load bearing properties of lubricants are considered. 11 refs. J. G. H.

867. Short versions of papers presented at the ASLE/ASME Lubrication Conference, Boston, 17–19 Oct 1960. Anon. *Sci. Lubric.*, Dec 1960, **12** (12), 21–8.—Abstracts of 15 papers covering gear and bearing lubrication, theoretical studies, and lubrication in nuclear power plants. J. G. H.

868. Modern trends in plug valve lubricants. A. A. White. *Sci. Lubric.*, Dec 1960, **12** (12), 19–20.—Functions of plug valve lubricants are briefly discussed and the development of special lubricants for this purpose is outlined, with special emphasis on the use of esters. J. G. H.

869. Hydraulic oil seals. K. R. Boreham. *Sci. Lubric.*, May 1960, **12** (5), 47–52.—Available types of seals are described and illustrated with data on their specific applications.

Causes of failure, seal friction, and the selection of seals for use with fire-resistant fluids are briefly discussed. J. G. H.

870. Engine rusting in service and dynamometer tests. P. A. Bennett. *Lubric. Engng*, 1960, **16**, 529–38.—The severe rusting of critical engine parts at low mileages in short-trip passenger car service is remarked and the General Motors dynamometer test for rating lub oils in this respect is described in detail. Correlation with field experience has proved satisfactory. The importance of close control of such variables as carburettor air humidity, blow-by rate, fuel composition and engine speed, load, and operating temp is emphasized as contributing to consistent results. J. G. H.

871. Some considerations in the selection and use of water soluble cutting and grinding fluids. C. A. Sluhan. *Lubric. Engng*, 1960, **16**, 110–18.—The special functions of cutting fluids in machining and grinding operations are discussed and illustrated and advantages obtaining from the use of tailored chemical fluids are indicated. Corrosion, bacterial contamination, and deposits encountered with water soluble fluids are considered. 20 refs. J. G. H.

872. Test procedures for the evaluation of cutting fluids. R. J. Yanis and G. F. Wolfe. *Lubric. Engng*, 1960, **16**, 164–70.—The need for an improved evaluation procedure for cutting fluids is emphasized and a comprehensive test programme set up by the General Electric Co is described. This comprises tests for rusting, fluid stability, mould and odour formation, and gumming tests, together with machinability tests. Statistical methods have confirmed reliability of test data so obtained, which have shown good correlation with field tests. Ten refs. J. G. H.

873. Testing hydraulic fluids. K. A. Galloway. *Sci. Lubric.*, May 1960, **12** (5), 43–6.—The principal tests carried out on new oils are described with indications of their significance and reference to standard methods. Tests on used oils are briefly discussed with notes on the significance of departures from original values. J. G. H.

874. Frictional resistance of a radially-loaded journal bearing with grease lubrication. R. K. Chakrabarti and R. J. Harker. *Lubric. Engng*, 1960, **16**, 274–80, 290.—While the theory of the lubrication of a sleeve bearing utilizing a viscous lubricant has been well established, that of the lubrication of journal bearings using conventional lubricating greases is by no means so well developed. An investigation is described of the measurement of frictional torque in a radially loaded plain bearing with varying loads, rotational speeds, and grease compositions. Details of the equipment used and test conditions selected are presented, and results obtained indicate that behaviour of the lithium greases employed was generally similar to that of a Bingham plastic. The friction torque in such a grease-lubricated sleeve bearing could, it was found, be expressed in a relatively simple equation involving load and speed. 11 refs. J. G. H.

875. Modification of force feed lubricators. R. L. Churchwell and F. J. Kokas. *Lubric. Engng*, 1960, **16**, 210–21.—Many lubrication problems encountered in gas engines may be attributed to the inconsistency of lubrication rates, based on the inaccurate "drop counting" and "turns" methods of adjusting the force feed lubricators used. Operational difficulties encountered using these methods are indicated and details are presented of a method based on measurement of the stroke of the lubricator pump, which enabled a more accurate control to be maintained and helped to develop lubrication consciousness in the operators. Supporting lab and field data are presented. J. G. H.

876. Infra-red hot box protection. W. M. Pelino and D. M. Key, Jr. *Lubric. Engng*, 1960, **16**, 363–70.—Overheated bearings in railway trucks have constituted an operational problem over a long period. Details are presented of an ir installation for the detection of hot boxes on freight trains in transit. Applications in yard approaches, main lines, and at intermediate points are discussed, together with economic considerations. J. G. H.

877. Spur gears—Hertzian contact times. E. K. Gatcombe, R. P. Hunnicutt, and G. F. Kinney. *Lubric. Engng*, 1960, **16**, 308–11.—The importance of contact time between mating gear teeth in the dynamics of gears and in gear lubrication is emphasized, definitions of contact time and of Hertzian contact time are presented, and kinematic relations are discussed with illustrative calculations. J. G. H.

878. Filtration of hydraulic oils. E. G. Ellis. *Sci. Lubric.*, Nov 1960, **12** (11), 18–25.—The growing awareness of the need for filtration in hydraulic equipment in service is noted, and significant developments in modern hydraulic design underlining this need are indicated. Filter characteristics and points in the selection of filters and in the evaluation of filter media are discussed in some detail, together with details of the bubble and boil point test and the evaluation of filter capacity and efficiency. J. G. H.

879. Lubricating oils (heavy duty) complying with Defence Specification DEF 2101. Anon. *Sci. Lubric.*, Nov 1960, **12** (11), 25.—Additional oils approved by the Directorate of Chemical Inspection as complying with the requirements of Defence Specification DEF 2101 are listed. J. G. H.

880. New U.S. gear lubricants. V. M. Farrant. *Sci. Lubric.*, Jan 1961, **13** (1), 23–5.—Weaknesses in the MIL–L–2105 specification for gear oils and the steps leading to the development of the MIL–L–002105A spec are indicated. Comparison of the lab axle performance tests called for in the two specs is presented, additives developed for the new spec are described, and the very limited acceptance and application of MIL–L–002105 is noted. J. G. H.

881. Some critical thoughts on the more recent developments in motor oils. W. Neidhart. *Sci. Lubric.*, Jan 1961, **13** (1), 14–17.—Details of the new MIL–L–2104B specification for motor oils, to come into force towards the end of 1961, are presented, and circumstances leading to the development of the MS test sequence are outlined, as are also the salient points of the tests comprising this sequence. It is pointed out that both MIL–L–2104B and the MS sequence are based on American needs and conditions and bear no relationship to European requirements. Suggestions for a European sequence of tests covering single grade, multi-grade, diesel, and two-stroke oils are put forward as a basis for further discussion. J. G. H.

882. Predicting grease performance from capillary viscometry data. J. G. Savins. *Lubric. Engng*, 1960, **16**, 108–9.—Variations in grease visc values obtained by capillary tube viscometry and with actual grease performance in large-scale centralized lubrication systems are noted and explained by a failure to correct for "end effects" characteristic of efflux type viscometry. A method of utilizing such corrections to predict field performance from capillary viscometry data is described. J. G. H.

883. Effect of gamma radiation on aircraft instrument lubricating oils. W. L. R. Rice. *Lubric. Engng*, 1960, **16**, 157–60.—Details are presented of an evaluation of the effects on three aircraft instrument lub oils (MIL–L–6085) of γ radiation. Standard test conditions were used and results obtained indicated a marked degradation of physical and chemical

characteristics—the greatest change being in the effect of the irradiated fluids on metals during oxidn corrosion. Ten refs.
J. G. H.

884. Development in lubricant additives. E. G. Curpher. *Sci. Lubric.*, June 1960, **12** (6), 26–7.—The significance of mol structure in assessing additive performance is discussed, together with the use of sulphonates to prevent piston sticking in diesel engines, oil–water emulsions, and multifunctional additives. J. G. H.

BITUMEN, ASPHALT, AND TAR

885. The development of bituminous surfacings in airfield construction. G. P. Jackson. *Inst. Petrol. Rev.*, 1961, **15**. 33–7.—Developments in airfield construction are traced from the early days of grass fields, through the use of tar macadam on hard core, to the wet sand mix process and the use of prefabricated bitumen surfacings. During the 1939–45 war, requirements for airfield runways became more and more stringent, and in the U.S.A. and U.K. two systems for classifying the different types of pavements were laid down. To-day the most common type of surfacing used is dense asphaltic concrete, and the use of the Marshall Test for controlling the quality of mixes is briefly described. A number of new airfield projects using a bituminous construction are examined, including Nice Airport, Christmas Island, and Palisadoes Airport, Jamaica.

In considering the increased loadings likely to be imposed by jet aircraft, a promising new material in this field is a mixture of bitumen and epoxy resin, which, when used as the binder in a fine graded asphaltic concrete mixture, provides a material which appears to have all the required characteristics.
A. D. S.

SPECIAL HYDROCARBON PRODUCTS

886. New findings on the properties of mineral oils in relation to the maintenance of transformer oils. (In German.) P. Stoll and R. Schmid. *Schweiz. Arch. angew Wiss.*, 1960, **26**. 455–77.—Characteristics and tests (including tan δ and resistivity) of transformer oil are outlined, and figures quoted, *inter alia*, for a low-aromatic oil (Diala C). Owing to ion mobility, shape of resistivity cell is more important for new than for aged oils, as with latter electrolyte type conductivity predominates. Ir spectra (numerous curves shown) are valuable guide to quality constancy, especially aromatic content; aging products and inhibitors can also be detected thereby. Ir curves on extensively (50-day Baader) aged oils shown. Topanol (ditert-butyl-*p*-cresol) is considered excellent inhibitor. Considerations governing design of oil regeneration plant (*e.g.* limiting factor of oil v.p. *ca* 0·1 mm/80° C, tendency of aromatic constituents of gas-absorbing oils to evaporate preferentially) discussed. Need for adequate capacity is stressed if plant is to be linked to transformer. Oil should be dried to <10 ppm H_2O before earth contacting. Natural earths are better than HCl activated. Description and flow diagram of regeneration plant, 1–5 mm, 60° C, three-stage degassing, resistivity test cells before and after earth treatment stage to indicate when earth is to be changed. For oil with acidity $<0{\cdot}3$ regeneration to tan δ/90° C 0·01, H_2O 1 ppm, 5–8% earth is required. Cost breakdown is given, regenerated oil inhibited with 0·3% Topanol can be produced for *ca* 0·3 Sw Fr/kg, *ca* half cost of new oil, moreover, plant is utilizable for transformer maintenance and new oil conditioning. Comparison of characteristics of new and inhibited regenerated oil; after seven day SEV aging 30–50% of Topanol in latter is exhausted. V. B.

887. Adsorption of some transformer oil oxidation products by solid insulants. (In Russian.) M. I. Shakhnovich and R. A. Lipshtein. *Vestnik Elektro-Prom*, 1959, **30** (5), 38–40.—Adsorption of acetic, stearic, butyric, and naphthenic (mol wt 282, from transformer oil dist) acids, and Fe and Cu salts of last, from transformer oil (140 g) by dried cable insulating paper or board (60 g). Acid concn such as to give oil acidity of 1 mg KOH/g, soap concn 0·1%. Tests in glass vessels, under N_2, 90°–98° C, 42 days. Adsorption measured by fall in acid val or metal content of oil. Adsorption decreases with increasing mol wt, acetic acid 94% adsorbed, naphthenic 13% (for paper), most adsorption occurs in first 3–6 days. Adsorption accompanied by fall in tan δ of oil. Cu naphthenate adsorbed more than Fe and both naphthenates more than corresponding acids. V. B.

888. Oil preservation systems. Factors affecting ionization in large transformers. A. T. Chadwick *et al. Elect. Review*, 1961, **168**, 200–3.—Dielectric stress across oil spaces can cause gas (N_2) release from supersaturated oil. Corona discharge through such gas can form amines by combination of ionized N and oil. Amines dissolve Cu cpds (*e.g.* CuS) from conductor surface, and these can be later pptd, to stain paper insulation.
V. B.

889. High vacuum drying and degassing of insulating oils for very high voltage cables. (In German.) K. Brinkmann and M. Beyer. *Elektrotech Z.* (*A*), 1960, **81**, 744–9.—Layout of degassing equipment shown and effect of reducing operating pressure illustrated. At 5–20 mm (equivalent to *ca* 30 ppm H_2O) elect strength is 180–220 kV/cm, lowering pressure (10^{-1}–10^{-3} mm) so as to reduce H_2O to 1 ppm raises value to *ca* 330 kV/cm. Resistivity (23° C) likewise increases, from 10^{14} to $5{\cdot}10^{15}$ ohm cm. Tan δ, however, *ca* $5{\cdot}10^{-4}$ (23° C) at 20 ppm H_2O, is not further reduced by fall in H_2O, although if latter rises above *ca* 40 ppm tan δ increases steeply. Effect of Fe (pick-up from gear pump, etc.) shown by circulating oil through system without magnetic filter, tan δ rising to $25{\cdot}10^{-4}$, but slowly falling to initial val of $5{\cdot}10^{-4}$ on inserting magnetic filter. Results of high vac degassing show improvement if measurement made *ca* 20 hr after end of degassing, probably due to ion mobility slowly attaining lesser val applicable at atm pressure. Diagrams of two cable impregnating processes given. V. B.

DERIVED CHEMICAL PRODUCTS

890. Oxidation processes in the petrochemical industry. Pt I. Vapour phase processes. P. W. Sherwood. *Petrol. Engr*, Feb 1961, **33** (2), C10.—A list is provided of the principal chemicals produced by oxidn processes and the feedstocks used in each case. Vapour phase oxidn processes are subdivided into those using the thermal, heterogeneous cat, and homogeneous cat methods. The last is not widely used at present, but the first two methods are in widespread use for the production of a large array of petrochemicals. Many of the processes are considered briefly. G. D. F.

891. Which acetylene feed is best? D. C. Lockwood. *Petrol. Refin.*, Nov 1960, **39** (11), 223–6.—The overall cost for the production of acetylene has been compared for feedstocks of methane, ethane, and propane. Actual yields of acetylene from the feedstocks are compared with theoretical calculated yields. The vol of reaction products, heat, and oxygen requirements are also considered. M. J. M.

892. Which isoprene route is best? V. J. Anhorn. *Petrol. Refin.*, Nov 1960, **39** (11), 227–8.—Isoprene is synthesized by the dehydrogenation of specific hydrocarbons having the required carbon skeleton or by degradative reactions of specific cpds having the desired carbon–carbon skeletons.

Production of isoprene by these two methods and by the use of suitable feedstocks, available in refineries, are discussed. M. J. M.

893. New process for pure *iso*amylenes. R. L. Foster *et al. Petrol. Refin.*, Nov 1960, **39** (11), 229–32.—Pure *iso*amylenes are of importance as intermediates in the manufacture of plastics and synthetic natural rubber. A new sulphuric acid process is described for the manufacture of *iso*amylenes of nearly 99% purity from the C_5 fraction of gasoline. The *iso*amylenes separated consist of 2-methyl-2-butene and 2-methyl-1-butene in a yield ratio 9 to 1. A flow diagram and details of pilot plant data are included in the article. M. J. M.

894. Polyolefin processes to-day. M. Sittig. *Petrol. Refin.*, Nov 1960, **39** (11), 162–222.—An extensive review has been made of literature and patents referring to polyolefin plastics. Process characteristics which govern the polyolefin processes are discussed with special reference to the action of the cat.

Metal cat are used in low pressure processes for the production of linear, relatively unbranched polymers. Processes using peroxy or azo cat, which are primarily free radical polymerization processes, take place at high pressures. The physical properties of typical polymers are given. M. J. M.

895. Petrochemical raw materials for synthetic textiles. P. W. Sherwood. *Industr. Chem.*, 1961, **37**, 118–24. *Cf* Abs **219**, 1961. W. A. M.

896. U.K. petroleum chemicals industry. V. S. Swaminathan. *Industr. Chem.*, 1961, **37**, 125–30.—Brief survey of U.K. petroleum chem installations, including processes, products, production and investment statistics, and future plans. W. A. M.

COAL, SHALE, AND PEAT

897. Chemism of coking, investigated on polymeric coal model materials. II. Structure investigation with help of radioactive carbon. (In German.) P. M. J. Wolfs, D. W. van Krevelen, and H. I. Waterman. *BrennstChemie*, 1959, **40**, 189–94.—Polymerization intensity (b) is introduced for characterizing polymer structures, whether they exhibit a net structure or not. Magnitude b = number of bridges/monomeric structural unit present in the mol (p.m.e.). In polycondensation products of aromatics with formaldehyde b therefore = the number of CH_2-bridges/monomeric unit. By using radioactive formaldehyde the number of formaldehyde mol which have reacted with a single aromatic mol can be determined simply, by activity measurements. From this number (b') b can be calc on the basis of analytical data. Treatment with radioactive C is described. Quant estimation of formaldehyde is performed successfully, with 1–2% accuracy, with dimedon (dimethyl*cyclo*hexanedione). A formula is presented for calculating b' val directly from activity measurements. Ten refs. R. T.

898. Investigations of coals of the Cretaceous and Tertiary formation. II. Plasticity properties and coking-technical characteristics of Cretaceous–Tertiary coals. Influence of the petrographic composition of these coals on their rheological behaviour. (In German.) H. Hoffmann and K. Hoehne. *BrennstChemie*, 1959, **40**, 219–27.—Plastic properties of 50 Cretaceous–Tertiary coals of varying origin are determined by dilatometer and plastometer, and their petrographic composition, qual and quant, microscopically ascertained. Results indicate that—exactly as was observed earlier with older coals of the Upper Carboniferous—clear relationships exist between their structural constituents and their rheological properties, therefore also to their technological behaviour. This information provides valuable indications for preparing and coking these coals. Practically all the macerales occurring in normal carboniferous coals are met with in Cretaceous and Tertiary coal formations. R. T.

899. Coal oxidation with air. Formation, composition, and properties of oxidized coals and humic acids. (In German.) O. Grosskinsky, G. Huck, and W. Lange. *BrennstChemie*, 1959, **40**, 252–61.—Location of O_2 on its introduction into coal mol structure does not suffice for final clarification of the coal mol structure. Number and variability of simultaneous reactions permit formation of many decomp products, but no well-defined substances, which can be considered as foundations of the coal mol. Oxidn first seizes H_2-rich portions, methyl and methylene groups. After their decomp no more humic acids are formed. Carboxyl groups are formed on high-mol components only at reactive positions, but not under the given reaction conditions, on highly condensed systems without side groups. In coals a statistical system of aromatics is present; it contains complexes of aromatics of one or many rings, generally mutually combined chemically or physically. In oxidn these combinations are loosened partly and O_2 enters at the free valencies with carboxyl group formation. Thereby part of the coal becomes alkali-sol. These sol portions are the regenerated humic acids arising from the bituminous portions. The residue insol in NaOH consists of higher mol wt materials. Components of the younger coals contain less aromatic portions, so can deliver more humic acids than the older coals. Eight refs. R. T.

MISCELLANEOUS PRODUCTS

900. Recent developments in petroleum wax production. Anon. *Oil in Canada*, 17.10.60, **12** (51), 34–8.—The methods of production and the potential sales of the various grades of petroleum wax are outlined. G. B.

CORROSION

901. Compilation and correlation of high temperature catalytic reformer corrosion data. Contribution to NACE Tech Group Cttee T-8. G. Sorell. *Corrosion*, 1958, **14**, 15–26t.—High temp corrosion data, relating to cat reformers, from 15 petroleum companies have been collected and summarized. Corrosion of steels in high temp sections is attributed to small quantities of H_2S in the hot reducing gases. Major variables are temp and H_2S content; others include pressure, H_2 content, cyclic action, and exposure time. Cr–Mo steels up to 9% Cr offer no improvement and 11→16% Cr steels show only moderate improvement over carbon steels. 18–8 Cr–Ni steel gives good resistance and 25–12 and 25–20 Cr–Ni steels are equal or superior to it. H_2S is more corrosive than other S cpds, and the scale formed tends to fall off, powder, and clog equipment, particularly cat beds. The most widely used materials are low Cr–Mo steels giving resistance to H_2 attack, but in cases where the H_2S level is sufficiently high 18–8 Cr–Ni is most common. Aluminium-coated low alloy steels provide good protection if the coat is firmly bonded and continuous. Cat desulphurization is preferred to amine treating for the removal of H_2S to reduce corrosion.

Other forms of corrosion attack found in these units are discussed. F. M. G.

902. Service life and relative cost data on reinforced epoxy pipe. H. D. Boggs and E. D. Edmisten. *Corrosion*, 1958, **14** (5), 114–16.—Information has been gathered from test installations of reinforced epoxy piping begun in 1954–55, mainly in oilfields

for salt water disposal and sour crude oil gathering, and for the disposal of some chemicals. Tables give service life in various corrodents with the conditions encountered, and compare costs of epoxy piping and piping which it has replaced. Commercial applications are listed and the causes and remedies of some failures are given. F. M. G.

903. Experience with sweet oil well tubing coated internally with plastic. NACE Tech Unit Cttee T-1C. *Corrosion*, 1958, **14**, 223–5t.—Information collected in a survey of tubing, coated internally with plastic, in use in sweet oil wells in the Texas and Louisiana Gulf Coast area is reported. The coatings used are mainly baked phenolic, baked modified phenolic–epoxy, and amine cured epoxy. The baked phenolic coating has been in use longest, and is therefore frequently used as a standard, but the baked modified phenolic–epoxy coating is considered by many to be better, particularly in resistance to abrasion and caustic muds. Few failures necessitating removal of string have been reported. It is concluded that plastic coatings are an effective and economic way to combat corrosion in sweet oil wells and that, in general, wells producing large amounts of water, wells subject to abrasion by sand and fluid velocity, and wells offshore or in marshes, where overhaul costs are high and chemical treatment is both expensive and inconvenient, are most suited to the use of plastic coatings. F. M. G.

904. Statistical concepts in the testing of corrosion inhibitors. C. C. Nathan and E. Eisner. *Corrosion*, 1958, **14**, 193–9t.—A difficulty encountered in corrosion testing is that of obtaining reproducible results, particularly in cases where steel is protected by inhibitors and corrosion is mild. Various organic inhibitors have been investigated in hydrocarbon systems containing solutions of electrolytes. In these systems, variations in wt loss are greater than in those without inhibitors. Four types of inhibitor at different concn have been compared by a static test, using kero and brine containing dissolved H_2S, and various inhibitors have been subjected to a dynamic test, using synthetic and natural well fluids as corrodents. Results of these tests have been statistically analysed, and a proposed explanation of observed statistical variations is given. With synthetic fluids generally there is a min scatter of results at max % inhibition, and there is often a danger area of acceleration, as exemplified by a plot showing results of inhibition with cetyl trimethyl ammonium bromide. Considerable variation is found in the corrosivity of untreated well fluids under dynamic test and some possible reasons are listed. Some attention is given to the calculation of inhibitor cost. F. M. G.

905. An electrical resistance method of corrosion monitoring in refinery equipment. A. J. Freedman, E. S. Troscinski, and A. Dravnieks. *Corrosion*, 1958, **14**, 175–8t.—The general methods of corrosion investigation in refineries suffer from several limitations: unit inspections, although routine procedure, like unretractable coupons do not detect rapid fluctuations; retractable coupons have to be cleaned before weighing, thus causing delay; effluent analyses refer only to overall corrosion rates. The requirements of a good corrosion measurement method are: detection and measurement during operation, rapidity, accuracy and reproducibility, and sensitivity. The use of an electrical resistance method, in the evaluation of corrosion inhibitors, in the effect of process variables on corrosion rates, and in the monitoring of sensitive locations in plant, is described. It is concluded that, as this technique fulfils all the requirements, it should become increasingly important for corrosion investigations of all types. F. M. G.

906. Controlling external corrosion on the Trans-Arabian pipeline. F. M. Maasry. *Corrosion*, 1958, **14** (3), 100–4.—The original coating for buried sections of this pipeline, of petrolastic primer, asphalt, glass fibre, asphalt, and asbestos felt, with padding in rocky areas, was found to suffer from inadequate bonding to the steel pipe. After five years of cathodic protection, a section having a low pipe-to-soil potential, although outwardly in good condition, showed poor bonding and accumulation of moisture. The original programme, using 100 V, 70 amp rectifiers in pump stations with magnesium anodes in the sections between, was found to be inadequate. Closer, unattended cathodic protection stations were introduced; the most economic spacing was found to be 11 miles. A programme to give complete protection to pump station piping is in progress: low pipe-to-soil potential areas have been located by measurements taken every 50 ft on a grid pattern, and supplementary protection will be provided by two 100 V, 25 amp rectifiers connected to graphitic anodes installed 20 ft from the piping. Asphalt-wrapped, rock-shielded, submarine lines are cathodically protected using steel anodes which are being replaced by silicon cast iron anodes because of cheapness and ease of installation. Other marine facilities are protected by magnesium anodes. F. M. G.

907. Some considerations in the design and application of an electrical resistance corrosion meter. G. A. Marsh and E. Schaschl. *Corrosion*, 1958, **14**, 155–8t.—The development of a corrosion probe technique for measuring the rate of corrosion while a test is in progress is described. The method consists of the measurement of the change in electrical resistance, and hence the reduction in thickness, of the uncoated arm of a two-armed metal probe. The technique is better used as a comparative test than as an absolute test of corrosion rate, and it cannot measure pitting. Jobs in which these probes have been used include the rotating bottle test; testing of inhibitors; study of corrosion in tankers, oil well piping, gasoline storage and blending tanks, engines, and an oilfield emulsion treater; lab examination of the effect of cathodic protection density on corrosion rate; measurement of minimum current density. Some of the factors (accessibility, safety, temp fluctuation) involved in the use of probes in refinery process streams are discussed. F. M. G.

908. Variables influencing corrosivity of oil and gas wells. H. E. Waldrip and J. A. Rowe. *Corrosion*, 1958, **14** (2), 108.—The variables involved in the corrosion of oil and gas wells, and the types of inhibitor used, are reviewed. One of the prime factors in the reduction of corrosion is the wettability of the oil. Where this is low, steel becomes water wet and thus susceptible to corrosion at fairly low water/oil ratios. An exception is the case of some heavy asphaltic crude oils, which are so viscous and appear to have such a strong bond to the steel that protection is obtained at higher water/oil ratios. A list of wettabilities of various American crude oils shows that sour crudes have no wetting tendencies and sweet crudes have variable wettability. Almost perfect corrosion protection was obtained in a sour well by treating with an oil soluble agent. Further study of the mechanics of corrosion and the function of inhibitors and their improvement is required and a greater uniformity of steel is needed. F. M. G.

909. Corrosion in amine gas heating solutions. F. S. Lang and J. F. Mason. *Corrosion*, 1958, **14**, 105–8t.—Although ethanolamines in the pure state, or in solution with water or glycol, are not corrosive to cast iron or mild steel at moderate temp, the development of amine scrubbing has produced a number of corrosion problems. Lab tests have been carried out on nickel, Monel, Inconel, Incoloy, mild steel, and types 304, 316, and 410 stainless steels in amine soln saturated with CO_2 and H_2S, to determine the effects of concn of amine, ratios of acid gas, temp, pressure, sludge, and velocity. Amines used were monoethanolamine and aminoethyl-ethanolamine. Monel and types 304 and 316 stainless steels had low corrosion rates

at all concn of amine when saturated with CO_2, and remained satisfactory up to 285° F and 35 psig, the highest temp and pressure reached. It was found that mixtures of H_2S and CO_2 in nearly equal proportions could be highly corrosive to Monel, but with a predominance of either H_2S or CO_2 Monel was satisfactory. Sludge was shown to increase corrosion rates and filtration is suggested to combat this. Types 304 and 316 stainless steels were satisfactory under all conditions. Some experiences with operating units are recorded.

F. M. G.

910. Fuel ash attack on aluminium coated stainless steel. J. E. Srawley. *Corrosion*, 1958, **14**, 36–8t.—An investigation of the effect of fuel oil ash on hot applied aluminium coated type 310 (25–20 Cr–Ni) stainless steel was carried out. Specimens were coated to an average coating thickness of 0·005 inch and some were heat treated to diffuse the aluminium into the steel, but it was found that after 24 hr at the test temp (1700° F) the effect of heat treatment was hard to discern. Both plain and coated specimens were contaminated with equal parts of Na_2SO_4 and V_2O_5 and heated in an unsealed muffle furnace for up to 14 days. Attack on uncoated specimens did not reach a depth equal to the coating thickness by the time the coatings had been penetrated on coated specimens, which result was confirmed by a boiler test. It is considered that these tests were over-simplified and that in order to investigate fully the whole range of variables encountered it is necessary to use a specially designed burner test rig and correlate the results with those of service tests.

F. M. G.

911. Theoretical aspects of corrosion in low water producing sweet oil wells. Status report of NACE Tech Unit Cttee T-1C. Task Group T-1C-4. *Corrosion*, 1958, **14**, 33–5t.—A study of scale-forming cpds confirmed that the principal corrosive agents in low water producing sweet oil wells are hydrolytic products of inorganic salts. Other contributory factors include electrochemical cells between metal and scale constituents, CO_2, and organic acids. Inorganic salts carried in water globulae and suspended paraffin are deposited, under favourable conditions, as a loose layer which builds up to a scale. Changes in physical conditions which alter the state of the scale, and scale porosity, affect corrosion rate, but the influence of "free water" is unknown. Usual detection methods are of little use, as caliper surveys tend to measure pits in the scale, and iron does not enter the product where it can be measured, but is retained in the scale. It is suggested that detection should be by comparison of analyses of bottom hole and well-head fluids for acid emulsions, inorganic salts, and hydrocarbon mass. Organic inhibitors, due to failure to penetrate scale, are of little value in combating the corrosion, and it is thought that a coating, with its smooth surface, gives less chance of scale formation.

F. M. G.

912. High temperature hydrogen sulphide corrosion of stainless steels. Contribution to NACE Tech Group Cttee T-8. E. B. Backensto *et al.* *Corrosion*, 1958, **14**, 27–31t.—Tests over a range 500°–1400° F and 0·03–10% (vcl) H_2S concn in H_2 show that, for normal conditions in cat reformers and desulphurizers, better protection is given by austenitic Cr–Ni steels than by 0→5% Cr steels, which give poor protection, and 7→16% Cr stainless steels, which are unpredictable. Weld and cast stainless steels exhibit lower corrosion rates than wrought types and heat treatment of austenitic steels gives a significant reduction in corrosion. Manganese modified austenitic steels below 900° F at various H_2S concn and the high Ni–Cr alloys, which also resist stress corrosion, at 750° F and 1·5% (vol) H_2S in H_2 give similar protection to that of the austenitic steels. Under the latter conditions aluminium and 12–4 Cr–Al steel show no metal loss and 20–2 Cr–Al steel exhibits little corrosion (at 1000°–1500° F this has a 50–100% greater corrosion rate than austenitic steels). Austenitic steels are susceptible to stress corrosion, but cases of this are only known to have occurred during shutdown and not during operation. The cause is thought to be polythionic acids formed from moist iron sulphide scale. Attempts have been made to simulate these conditions in the lab, but results are inconclusive and further work is required to determine the role of these acids.

F. M. G.

913. New low-cost inhibitor for amine-sweetening systems. Anon. *Oil Gas J.*, 6.2.61, **59** (6), 138.—Corrosion in amine gas-scrubbing systems can be drastically reduced by the addition of sodium meta-vanadate. Recommended inhibitor concentration is 0·05% wt and addition at start-up of from two to two and a half times the calculated amount of vanadate will ensure the formation of a protective coating and provide the recommended concentration.

The inhibitor is readily dissolved in hot water and can be added in this fashion to the system. Normal precautions to avoid inhaling excessive inhibitor dust should be observed.

A. D. S.

914. Special techniques cut corrosion costs. D. R. Fincher. *Petrol. Engr*, Feb 1961, **33** (2), B30.—Three new corrosion inhibition techniques in wells, known as the inhibitor squeeze, the tubing displacement, and slug, circulate, and park methods. The next section deals with the evaluation of the effectiveness of inhibitors—the continuous exposure, film persistency, film forming, and film strength tests are described. Finally, field experience and the essentials of a successful corrosion programme are discussed.

G. D. F.

ENGINES AND AUTOMOTIVE EQUIPMENT

915. Rotary piston is new idea in engines. Anon. *Petrol. Engr*, Jan 1961, **33** (1), B40.—The new Wankel IC engine is described briefly. This utilizes a rotary piston and has no reciprocating parts. It can deliver better than 1 hp/lb of engine wt and operates satisfactorily on low octane fuels.

G. D. F.

916. Polytetrafluoroethylene insert compression rings in radial gas engines. D. W. Sawyer and D. A. Paull. *Lubric. Engng*, 1960, **16**, 406–9.—Excessive compression ring wear in the operation of 11- and 12-cylinder radial gas engines has led to the development of a cast iron compression ring containing a polytetrafluoroethylene–glass laminate insert. Design of such rings is briefly described, and records of operating experience with engines so equipped are presented and indicate considerable savings in oil and maintenance man-hours.

J. G. H.

SAFETY PRECAUTIONS

917. Cut the total cost of your accidents. J. H. Herbert. *Oil Gas J.*, 6.2.61, **59** (6), 118–19.—Injuries, fires, and personal and property damage claims can add up to 10–20 c/share of outstanding stock each year in an oil company, if the total cost of such economic waste is determined. Since there is no argument about the humanities of safety, this article (first of a series) is directed at the economic value of a sound accident and fire-protection programme. The first step is to get total accident costs, and items contributing are enumerated. The cost factors connected with employee injuries and fires are broken down and a section is devoted to factors such as inconvenience to customers and bad employee relations, which could be the most expensive items to consider. A. D. S.

918. How Humble cut volume of pollutants by 80% in eight years of effort. D. H. Stormont. *Oil Gas J.*, 6.2.61, **59** (6), 124–8.—In 1952 Humble found that the pollutants at their Bayway refinery could be broken down as follows—52% due to combustion operations, 32% as a result of evaporation losses, and 16% concerned with fluid cat cracking. In 1960 combustion operations contributing to pollution were down to 8% of the 1952 level as a result of using fuel of lower S content, not burning H_2S and acid sludge, installation of smokeless flues, and reduction of emergency flaring. Evaporation and leakage losses are now down to 23%, as a result of installing floating roof tanks, use of vacuum trucks to pick up spilled oil, and closed pre-separators for skimming oil from sewer water. Cat dust losses have been cut to 54% of the 1952 level, and this has been accomplished through control of operation equipment, increased capacity of the cat recovery system, use of stronger improved cat, and elimination of waste-heat boiler cleanings. A. D. S.

919. Lighting in the petroleum industry. S. E. Harris. *Petroleum, Lond.*, 1961, **24**, 47.—Because of the hazardous nature of the processes used, most oil companies use lighting equipment issued with a Buxton certificate of the Ministry of Power (Mines Dept). The types of inflammable gases and vapours and permissible temp rise and max safe flange gaps of fittings for each type are considered. There is a discussion of the most suitable types of lighting (*e.g.* tungsten lamps, fluorescent lamps, mercury lamps, etc.) under various conditions. Finally, lighting in control rooms, exterior plant, utilities areas, and depots is dealt with. G. D. F.

ECONOMICS AND MARKETING

920. Estimating investment costs. Anon. *Oil Gas J.*, 6.2.61, **59** (6), 120–3.—Often offsite investment costs are overlooked because they are assumed to amount to very little. In fact, these costs can exceed the battery-limits investment and must be considered along with an estimate of the working-capital requirement for any completely descriptive analysis. In determining the cost of offsite facilities the following must be considered—steam and power generation, cooling towers, water treatment and distribution, storage, and buildings—and their cost is shown in either graphical or tabular form.

An equation is presented for calculating the total cost of battery-limits investment. It is applicable to new units only and is not recommended for revisions to existing units. An example is given of the costing of a reactor shell designed for 950° F service. A. D. S.

921. World output gains 7·2% in 1960. Anon. *Oil Gas J.*, 30.1.61, **59** (5), 142.—The centre of gravity of the free world's crude-producing industry moved farther towards the E Hemisphere during 1960 as the Middle East accounted for the major share of a gain of more than 900,000 bd in areas outside the U.S.A. Middle East fields produced 14% more oil in 1960 with a rise of *ca* 643,800 bd. N Africa, with a five-fold increase in output from the French Sahara, also won a significant share of new markets by supplying nearly 17% of the world-wide increment. Venezuelan output, up *ca* 2·1%, accounted for 6% of added production, while the rise in Canadian output was equal to *ca* 2·5% of the overall gain. Argentina's 30% gain in crude output was equal to 4% of the new supplies outside the U.S.A.

Tabulated details are given, by country, of production, estimated reserves, and refining capacity. A. D. S.

922. 1960 was a good year for gas. Anon. *Oil Gas J.*, 30.1.61, **59** (5), 122–3.—In 1960 in the U.S.A. 13 trillion cu ft of natural gas was marketed, an increase of 7·8% over 1959. Natural gas reserves were up to 273·4 trillion cu ft, a 4·1% gain over 1959. 3952 gas wells were finalized, representing a 4·7% gain over 1959. Natural gas liq made a 4·6% rise, which, though not up to par, is an indicator of full recovery from the sharp drop experienced in 1957.

At the present rate of annual consumption of 13 trillion cu ft of natural gas the current reserve figure will last only 21 years.

Details are given of production, the number of field wells and successful wildcats, and the reserves, all by states. A. D. S.

923. Production–demand ratio hits new low. Anon. *Oil Gas J.*, 30.1.61, **59** (5), 120–1.—Crude production in the U.S.A. represented only 71·5% of total demand for the year. Production averaged 7,032,000 bd and was 22,000 bd less than in 1959. Tabulated data are presented for U.S. production by state and also per well by state. A. D. S.

924. U.S. petrochemicals to continue rapid growth. E. R. Boedeker. *Petrol. Engr*, Jan 1961, **33** (1), C8.—The state of the petrochemical industry in the U.S.A. is reviewed. It is shown that the greatest vol of petrochemicals produced in the past are aliphatic materials, and this is expected to continue to be the case. The present production of various aliphatic and aromatic petrochemicals is compared with figures of several years ago, and predictions are made as to the probable production in 1965. In most cases the growth has been steady, and in some cases spectacular. Inorganic petrochemicals (ammonia, carbon black, sulphur) are also mentioned. G. D. F.

925. New markets hold key to Canada's refining expansion. E. D. Loughney. *Petrol. Engr*, Jan 1961, **33** (1), C16.—Canada is stated to have 43 operating refineries with a capacity of 922,000 bd, representing a 17% surplus of refinery capacity. However, domestic sales are expected to increase, and the market for petroleum products is predicted to double in 12 years. The present tendency is towards gasolines of high ON, for which special processes (*e.g.* alkylation, cat reforming, cat cracking, and hydrogen treating) are widely used. Efficiency in the refineries is being increased by automation. G. D. F.

926. Petrochemicals in Canada. J. L. Porter. *Petrol. Engr*, Jan 1961, **33** (1), C19.—The growth of the petrochemical industry in Canada is compared and contrasted with that in

the U.S.A. Special problems facing the industry in Canada are outlined, and the present producing areas and major products are listed. Capacity is at present ahead of demand. Aliphatic and aromatic chemicals, synthetic rubber, plastics and resins, ammonia and fertilizers, and sulphur are considered separately. Market research is being carried out, and there are some remarks on the expected growth of the industry.

G. D. F.

927. Petrochemicals in Latin America. R. J. Cameron. *Petrol. Engr*, Jan 1961, **33** (1), C35.—The general economic situation in Latin America is reviewed. It is shown that, up to now, early developments in the petrochemical field have been mostly confined to the manufacture of fertilizers. The potential demand for other products is dealt with, and an attempt is made to evaluate investment possibilities.

G. D. F.

MISCELLANEOUS

928. International oil—its ills and cures. A. C. Long. *World Petrol.*, Jan 1961, **32** (1), 37.—Although the history of the oil industry has been referred to as miraculous, there have been at times periods of crude oil surpluses and shortages, together with phases of over-production and collapsing prices. These were particularly evident during and following world war I and in the economic depression of 1931. At the present time there are also many problems to be faced, such as the tide of nationalism which imposes leasing demands on international companies. The future of the industry, however, seems well assured, with the increasing consumption of petroleum products throughout the free world. Present world demand is now 18·8 million bd, *ca* four times that of 1938. Nuclear, solar, and other unconventional forms of energy are unlikely to have little effect on the accelerating use of oil for at least 20 years. Increasing exports of oil from Russia may be a hazard to world marketing stability, but it is not likely that this will affect the expansion of U.S. operations throughout the free world.

C. A. F.

929. The U.K. oil industry—1960. C. W. Wood. *World Petrol.*, Jan 1961, **32** (1), 45.—Petroleum in the U.K. continues to increase in importance in the country's fuel economy in relation to coal, and during the first six months of 1960 oil was replacing coal at an annual rate of 38 million tons, 22 million more than the annual rate in 1956. Both the Central Electricity Generating Board and the gas industry are using increasing amounts of oil, the latter for coal gas enrichment. During 1960 there were further improvements in reducing distribution costs, and an experimental centre for automatic control of product receipt and distribution has recently been equipped. There was limited gasoline price-cutting during 1960 by smaller independents, and it is expected that there will be increased competition in all fields of oil trading in 1961. U.K. demand should rise to 50 million tons by the mid 1960's, reaching *ca* 57 million tons in the early 1970's.

Main refining developments in 1960 include the bringing in of the Milford Haven refinery and the rise in output at BP Kent from 7·1 to 9·0 million tons pa. During the first seven months of 1960 refinery throughput averaged 3,520,700 tons/month, compared to 3,237,800 tons over the same period in 1959. Developments in the petrochemical industry are noted.

C. A. F.

930. Applied hydrocarbon thermodynamics. Pt 20. W. C. Edmister. *Petrol. Refin.*, Aug 1960, **39** (8), 113–20.—PTC K charts are presented for 16 hydrocarbons and the step-by-step procedure for the use of the charts is given in addition to a sample calculation. The accuracy of the charts are given in the ranges 0–300 psia, 301–700 psia, and 701–3600 psia.

M. J. M.

931. Disposal of refinery acid sludge. 2. P. W. Sherwood. *Petroleum, Lond.*, 1961, **24**, 65.—When hydrolysis methods are not feasible, acid sludges can be decomposed thermally in the presence of a reducing agent to give SO_2, which can be reconverted to sulphuric acid. Some of the problems encountered in this decomposition are mentioned. In general, two approaches are used. Medium temp decomposition (250°–650° C) leads to *ca* 80–85% SO_2 recovery. For light sludges a high temp process (1100°–1200° C) can be used. The remainder of the paper deals with certain other possible processes for the decomposition of sludges under special conditions, *e.g.* the fluidized external coke recycle system, external heating methods, etc.

G. D. F.

932. Gas turbine applications in the hydrocarbon process industries. D. F. Bruce. *Petrol. Engr*, Feb 1961, **33** (2), C19.—Gas turbines have proved useful in the hydrocarbon process industries for the supply of compressed air, hot gases, and mechanical power. Various specific uses are mentioned, and there is a brief section on maintenance and operating costs.

G. D. F.

933. Telecommunications in the petroleum industry. Anon. *Petroleum, Lond.*, 1961, **24**, 95.—Some recent developments and equipment in telecommunications in the petroleum industry are reviewed. These include the use of a computer to control a cat cracker 450 miles away (California); the location of personnel in a large plant; communications between Gachsaran and Kharg Island (Persian Gulf) and in Venezuela; and the use of the Decca system for tanker navigation in the Persian Gulf.

G. D. F.

934. Examples of radio communication equipment for the oil industry. A. St G. Prynne. *Petroleum, Lond.*, 1961, **24**, 91.—This brief paper considers the use of HF radio equipment in the oil industry. Single sideband radio telephony, frequency-shift telegraphy, equipment for long-distance survey groups, operational base equipment, and pipeline communications are dealt with.

G. D. F.

BOOK REVIEWS

Soap Films. Karol J. Mysels, Kozo Shinoda, and Stanley Frankel. London, Oxford, New York, Paris: Pergamon Press, 1959. Pp. x + 116. 40*s*.

The authors say in their preface that they are presenting an account of the process of thinning of soap films and then warn the reader that there are many mechanisms and "consequently many types of films . . ." This seems to be putting the cart before the horse, and it is noticeable that they have given quite insufficient attention to the composition of the adsorbed layers which enclose films. They warn the reader not to expect "completeness and coherence of explanation of a fully completed investigation." This is only too true, as the book contains little beyond what would be expected in the introductory chapter of a Ph.D. thesis on this topic. Figs 6.1 and 6.2 are exceptions. Perrin's stratified films are mentioned in a section entitled "The Multiplicity of Black Films," and one wonders whether the authors have ever seen one. Helped by a turgid style,

the contents occupy 88 pages plus 19 pages of bibliography, which, a footnote to p. 74 tells us, was prepared *after* completing this work; 3 pages of index to the bibliography, which is in chronological order; and the index proper which is blown up to 6 pages by the inclusion of numerous absurdities of no value to the reader. There are five illustrations whose quality of colour reproduction is poor, and one cannot help recalling the superlative photomicrographs of Perrin's stratified films shown in the Paris exhibition in 1937. Nevertheless, the book does bring together scattered material, and it should be read by anyone working on film drainage. The reviewer cannot, however, advise them to buy it at 40*s*. A. S. C. L.

Achema Jahrbuch 1959/1961. Vols I and II. Frankfurt am Main: Dechema, 1961. Pp. 1346.

This triennial publication is very widely known, and this review is therefore mainly concerned with those aspects in which the present edition differs from previous ones. The book is now published for the first time in two volumes. The change has been necessitated by the increase in the number of pages to 1346, compared with 1068 in the 1958 edition. The number of exhibitors at the 1961 Achema will be over 1200—an increase of approximately one-third over the number in 1958.

Section III of this yearbook (" Research Institutes ") has grown from 179 pages in the previous edition to 292 pages in the present edition. It is noteworthy that this section gives 66 entries for German research establishments and eight entries for British research establishments. According to information furnished to this reviewer, at least part of this poor British showing is due to lack of response from establishments which would otherwise have been included. It is to be hoped that all those concerned will make efforts to ensure that future editions will give a more representative picture.

A new method of presentation has been introduced for Section VI—" Who can supply?" In the edition under review suppliers are classified under alphabetically-arranged subject headings in English. In previous editions the names of suppliers appeared only under German subject headings, and cross-reference had to be made from an index of subject headings in English (or French or Spanish). The new arrangement is certainly more convenient to use, although it must entail publishing different editions of the yearbook in different countries.

A noteworthy feature of this edition is a biography of the late Dr Max Buchner, who founded the Achema and the Dechema. It is interesting to learn that the first Achema, held in Hanover in 1920, had 75 exhibitors and an area of 6000 sq ft, compared with 1200 exhibitors and 860,000 sq ft in 1961. This remarkable growth is indeed a tribute to the work of Dr Buchner and his successor, Dr H. Bretschneider, and to the progressive outlook of the firms that supported the exhibition until it reached maturity.

The yearbook bears the sub-title " European Catalogue of Chemical Plant/Apparatus/Instruments " on its front cover. No doubt its publishers (Dechema) desire to make it fully representative of all European countries, but in practice it is probably inevitable that a technical exhibition organized by a national organization should have a preponderantly national flavour. This can be said without suggesting any bias; it is easier to obtain information and co-operation in one's own country than it is to get them from abroad. An indication of this problem has already been noted in the reference to the section on research institutes. Another example is the list of consultants (a new feature in this edition) which appears on pp. 1102–3. It is limited to members of the " Consultants " Group of the Gesellschaft Deutscher Chemiker. A. J. V. U.

Applied Thermodynamics. S. H. Branson. London, New York, Toronto: D. Van Nostrand Co. Ltd, 1961. Pp. vii + 230. 30*s* (paperback 22*s* 6*d*).

In the preface to " Applied Thermodynamics " the author points out that it is a false doctrine to regard thermodynamics as dull and difficult, and in the text he ably proves that the subject can indeed be brought to life. He has, however, set himself a difficult task, since he has attempted to condense a full university chemical engineering course of some 80 lectures plus problem classes into 220 pages of text. By restricting the material, in the main, to the essentials of the subject, he has succeeded, and has produced a much needed basic thermodynamics text suitable for the undergraduate teaching of chemical engineering, and at a price which all students will be able to afford. The book is also recommended to anyone wishing to take a refresher course in thermodynamics.

Perhaps the two outstanding features of the book are the almost deceptive ease with which sometimes complicated mathematical steps are explained, and the excellent arrangements of examples and notes which illustrate each chapter. Unfortunately, an otherwise excellent book is spoilt by a number of points in the text which give rise to irritation. The most serious of these are the all too frequent use of the first person plural, and a number of minor printing errors, which could so easily have been corrected before publication. P. J. K.

Pressure Drop for Flow of Fluids in Round Pipe. Leo Friend and Leon Samoiloff. New York: The M.W. Kellogg Company.

This book comprises a large number of charts and tables which allow the pressure drops of liquids and gases flowing in round pipes to be rapidly calculated. Each of the series of charts is for a single viscosity and gives pressure drop/flow rate curves for a number of pipe sizes. Subsidiary charts enable the effect of pipe roughness and of changing kinetic head in gas flow to be evaluated. Conversion charts for flow rate, given in barrels per day on the main charts, to U.S. gal/hr and U.S. gal/min, are given. No conversion is provided to Imperial gallons.

Although most normal pipe sizes and viscosities are included, the charts do not cover viscosities of more than 1000 cS (these are sometimes encountered in pipeline operations) or include pipes of ¾-inch wall thickness and of outside diameter between 14 and 24 inches (these are commonly used).

Calculation of the pressure drops in gas flow under conditions when the pressure drop is large is facilitated by a chart giving correction factors for various ratios of twice the inlet kinetic head to inlet pressure. By re-labelling the curves on this chart, one calculation operation could have been avoided, but it would have been simpler to include extra charts relating inlet kinetic head to flow rate and line size. R. J. R.

Air Pollution. World Health Organization Monograph Series No. 46. Geneva: World Health Organization, 1961. Pp. 442. 40*s*.

This monograph contains 14 chapters on air pollution, including the role of meteorology, economic and social aspects, and site selection and zoning. Seven chapters come from the U.S.A., two from England, and one each from Belgium, Canada, France, Italy, and South Africa. To ensure that the information represented international opinion, each chapter was approved by a panel of experts from six countries.

As might be expected in a WHO publication, effects of air pollution take an important place. The longest chapter, the effects on human health, has 51 pages of discussion and gives over 400 references. In contrast, the principles of oil

combustion are dealt with in one page of a chapter devoted to fuel selection and utilization.

The book contains a tremendous amount of information, although little is of direct use to the combustion engineer, but it will be very useful to IP members who are interested in other aspects of air pollution, particularly the three chapters mentioned in the first paragraph. G. U.

Introduction to Petroleum Chemicals. Ed. H. Steiner. Oxford, London, New York, Paris: Pergamon Press, 1961. Pp. x + 200. 50*s*.

This is a reprint of a series of lectures on the petroleum chemicals industry given in the autumn and winter of 1959 at the Manchester College of Science and Technology.

The chapters deal, in turn, with cracking processes for olefins, separation processes for olefins, products from ethylene and propylene, polymers from ethylene and propylene, the production and use of butadiene, aromatics from petroleum, styrene, and polystyrene, acetylene from hydrocarbons, and carbon black. There is a short subject index.

These lectures were worth publishing and have appeared with admirable speed; a commendable feature is the inclusion of techno-commercial information in most of the chapters. Any criticism is disarmed by the editor's preface.

The set-up is excellent and there are very few misprints. Whilst the price of 50*s* seems excessive, it is supposed that we shall have to become reconciled to a new order of cost.

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OILFIELD EXPLORATION AND EXPLOITATION

GEOLOGY

935. Sedimentology and the search for oil. R. Passega. *Rev. Inst. franç. Pétrole*, 1960, **15**, 1731–40.—The structural approach in oil exploration requires only general knowledge of the sediments and has given excellent results. Sedimentological studies are generally insufficiently precise to be useful. Most studies have been on recent deposits, especially littoral sediments which are laid down by a great variety of agents. Moreover, these are vulnerable to erosion and quite rare in ancient deposits. Platform slope deposits and the deposits of the deeps have been studied, but it seems that the deposits of the continental platform may most closely resemble those of the widespread shallow ancient interior seas. The exceptional conditions following the Quaternary glaciation may make the platform deposits non-typical. Hence the sedimentology of ancient rocks must be based on those rocks, recent deposits being used where possible to check hypotheses regarding the former. Work on recent deposits gives much information, but it is largely in two dimensions; changes have taken place in old deposits, control points are few, but the third dimension plus correlation can give their form at times.

Many concepts need to be reviewed; sands are not necessarily confined to littoral zones, and gypsum can be deposited at depth. Plots of the median dia for a sediment and the one-percentile dia at the large size end of the cumulative curve give characteristic fields for deposits of various types. Ancient sediments are often more uniform than those of modern littoral zones. Widespread ancient sands appear to have been spread by wave action. When the supply of sediment, subsidence, and the depth of water are in equilibrium the surface of the sand deposit is an almost horizontal profile of equilibrium. Temporary increase in supply gives a tongue of deposits.

There is evidence that clay beds deposited in quiet periods may resist erosion more than sands, and this may give pinch-outs which are not coast lines but controlled by certain depths of water. Ancient submarine highs may be recognized. Some clean shoestring sands may be due to wave working of dirty sands in transit, with the deposition of the fines below wave action base.

The nature of the hydrocarbons may depend on the depth of water. In the Po Valley, hydrocarbons seem to have been trapped in carbonates at the time of deposition, and the CH_4/C_2H_6 ratio seems to decrease with depth of deposition. The same is true of some sands. It appears that a water depth of 40–50 m is necessary to form oil in these rocks.

G. D. H.

936. Mineralogy of Jacksonburg (Middle Ordovician) formation in Eastern Pennsylvania and Western New Jersey. S. Ray and H. R. Gault. *Bull. Amer. Ass. Petrol. Geol.*, 1961, **45**, 39–50.—The Jacksonburg formation is a sequence of limestones grading upward from massive coarse-grained grey types into an impure, fine-grained, black slaty variety. Calcite is the predominant mineral; there is a small amount of dolomite.

The bulk of the Jacksonburg is characterized by the presence of chlorite; its presence in small areas isolated from the main belt suggests that the formation was deposited in an extensive sea rather than in isolated small basins and that the present outcrop pattern is the result of erosion.

The primary objective of the investigation was to determine the mineral composition of the limestones and lateral or vertical variations in the mineralogy which could be related to the stratigraphy. E. N. T.

937. Contemporaneous normal faults of Gulf Coast and their relation to flexures. F. R. Hardin and G. C. Hardin, Jr. *Bull. Amer. Ass. Petrol. Geol.*, 1961, **45**, 238–48.—A contemporaneous fault is a fault along which movement was contemporaneous with sediment deposition. Such a fault has been called a "progressive fault," "gravity fault," "depositional fault," and "hinge-line fault," but the term contemporaneous fault is much more definitive and should be used to describe this type. Increase in the thickness of the beds on the downthrown side of a fault when compared with the same beds on the upthrown side is generally considered to be evidence for a contemporaneous fault. In general, the younger the sediments, the more numerous are contemporaneous faults.

A flexure or hinge-line is a zone downdip from which the rate of dip and thickening of sedimentary beds is accentuated. Flexures affect most Cenozoic beds in the Gulf Coast, and most flexures are marked by contemporaneous faults of regional extent which tend to accentuate the effect of a flexure on sedimentation. E. N. T.

938. Geology of South Pass Block 27 field offshore, Plaquemines Parish, Louisiana. D. A. Smith. *Bull. Amer. Ass. Petrol. Geol.*, 1961, **45**, 51–71.—The South Pass Block 27 field is associated with an intermediate-depth salt dome. Knowledge of the structure is limited to the N flank of the salt dome and many relationships of salt and structure are yet to be determined. The field ranks high among the giant oilfields of Louisiana in terms of ultimate oil recovery, and the entire producing section of the field is Plio-Miocene in age, composed of thick layers of soft sands and shales.

A marked effect on structural configuration is made by contemporaneous faults traversing the structure. This type of faulting, commonly encountered in the Gulf Coast, is characterized by a greater thickness of sediments in the downthrown block than in the upthrown block, and by an increase in throw of the fault with increasing depth. E. N. T.

939. Ouachita Mountain core area, Montgomery County, Arkansas. W. D. Pitt *et al.* *Bull. Amer. Ass. Petrol. Geol.*, 1961, **45**, 72–94.—Detailed mapping and study of the Ouachita Mountain core area of SW Arkansas has yielded new information regarding its stratigraphy and structure. Significant discoveries include finding that *ca* 105 ft of Collier shale is exposed in and along Upper Collier Creek Canyon, which at this location consists mostly of thin beds of dark-coloured siltstone and shale. Along this Canyon the base of the Crystal Mountain sandstone is prominently exposed, but there is no evidence of an unconformity between the Collier shale and Crystal Mountain sandstone.

The structure of the outcrop areas of the Crystal Mountain sandstone throughout the core area consists essentially of anticlinal hills separated by synclinal valleys of Mazarn shale. E. N. T.

940. Central Nebraska oil play gains momentum. J. A. Kornfeld. *World Oil*, March 1961, **152** (4), 80.—Active wildcatting is under way in the Central Nebraska Basin following successful finds in Red Willow County flanking the Cambridge Arch. Palæozoic beds are being tested in nine counties in a search for new reserves from less than 5000 ft depth. The basin is a N extension of the Salina Basin and contains Palæozoic rocks above basement. Main targets range from the Upper Cambrian Lamotte (Reagan) sandstone through Lower Pennsylvanian Lansing–Kansas City limestones. The Lamotte, for example, produces from the recently discovered Sleepy Hollow field in Red Willow County, and this pay is a good target for the E flank of the Cambridge Arch. C. A. F.

941. Interpretation of sedimentary features in Brazer limestone (Mississippian) near Mackay, Custer County, Idaho. B. A. L. Skipp. *Bull. Amer. Ass. Petrol. Geol.*, 1961, **45**, 376–89.—The Mississippian Brazer limestone exposed in one of the larger outcrops of the Mackay Quadrangle, Idaho, forms the subject of this paper. The rocks, which are approx 7400 ft thick, range in age from Osage to late Meramec, possibly Chester, as determined from endothyrid foraminifera. They are underlain by *ca* 4000 ft of argillite, and overlain by Challis volcanics.

The great thickness of the Brazer in this area, together with Petrographic studies and faunal assemblages, suggest that it was deposited in a marginal miogeosynclinal environment. The lower part was laid down in shallow, quiet marine waters; the middle in freely circulating marine waters of moderate depth; and the upper in a fluctuating marine environment near a low landmass probably on the W or SW. E. N. T.

942. Regional study of jointing in Comb Ridge–Navajo Mountain area, Arizona and Utah. R. A. Hodgson. *Bull. Amer. Ass. Petrol. Geol.*, 1961, **45**, 1–38.—Present theories of the origin of joints in sedimentary rocks are based primarily on the observation and interpretation of their more obvious features such as parallelism, the angular relations in plan between joint sets, and between joint sets and other structural features such as folds and faults. The present work is restricted to a study of joints in the sedimentary rocks cropping out in the Comb Ridge–Navajo Mountain area, Arizona and Utah, the objectives being, first, to record the physical features of individual joints and, secondly, to define the regional joint pattern and its areal relations to the folds of the area.

A simple, non-genetic joint classification is presented based on the spatial relations of joints and the plumose structures on joint faces. Joints are grouped as systematic or non-systematic with cross-joints defined as an important variety of non-systematic joints. The question of the ultimate origin of the regional joint pattern and its genetic relation, if any, to other structure at depth cannot be answered on data now available. E. N. T.

943. Critical review of some tectonic problems in Cordilleran foreland. F. W. Osterwald. *Bull. Amer. Ass. Petrol. Geol.*, 1961, **45**, 219–37.—The tectonic framework of the Cordilleran foreland is controlled by structures in basement rocks of pre-Cambrian age. Most structures within the foreland are analogous in size, configuration, and trend; and the tectonic framework of the foreland is in sharp contrast to that of the adjoining Cordilleran geanticline. Many faults that cut rocks of Palæozoic and Tertiary age in the foreland, formerly interpreted as overthrusts, are related to recurrent and preponderantly vertical movement along pre-Cambrian basement structures. This vertical movement has produced most fold and fault structures, and by repeated deformations of old (pre-Cambrian) structures even relatively young Tertiary rocks are slightly deformed and jointed. E. N. T.

944. Hydrodynamic entrapment of oil and gas in Bisti field, San Juan County, New Mexico. R. P. McNeal. *Bull. Amer. Ass. Petrol. Geol.*, 1961, **45**, 315–29.—Oil and gas production of the Bisti field from Cretaceous Gallup sandstone extends along a narrow belt more than 30 miles; the accumulation is controlled by permeability and hydrodynamics, with no structural closure or nosing.

The accumulation at the W end forms an oil column more than 365 ft in ht, and this is sufficient to develop a capillary pressure of more than 52 psi at the updip edge of the accumulation. This capillary pressure under hydrostatic conditions should be sufficient to cause much of the oil to migrate updip out of the permeability lenses; favourable hydrodynamics are responsible for retaining the additional oil. E. N. T.

945. Distribution of Ordovician graptolites in eugeosynclinal facies in Western North America and its palæogeographic implications. R. J. Ross, Jr. *Bull. Amer. Ass. Petrol. Geol.*, 1961, **45**, 330–41.—Two facies comprise Ordovician strata of W N America. One of these is characterized by detrital siliceous, argillaceous, and volcanic rocks and a graptolite fauna; the other is composed predominantly of carbonate rocks containing a shelly fauna.

This paper attempts to scrutinize the general facies pattern and to evaluate the limited evidence for the geographic boundaries of the detrital facies in particular. Faunal evidence, particularly the graptolite, has been used to establish correlation, but also as a basis for assessing ecologic and palæogeographic implications of that eugeosynclinal facies. E. N. T.

946. Effect of regional variations of crude oil and reservoir characteristics on *in situ* combustion and miscible-phase recovery of oil in Western Canada. B. Hitchon *et al.* *Bull. Amer. Ass. Petrol. Geol.*, 1961, **45**, 281–311.—More than 20 billion brl (exclusive of the crude oil in the McMurray formation) of original in-place crude oil has been discovered in W Canada to the end of 1959. It is expected that only *ca* 4·75 billion brl will be produced by primary methods and water flooding; secondary recovery methods, such as *in situ* combustion and miscible-phase flooding, could result in the production of approx a further 8 billion brl. This study presents reviews of the pertinent factors concerning the technological application of both methods.

Generally, it appeared that thermal methods were most suited to crude oils in the subcrop and Sweetgrass Arch regions of the Upper Devonian, Mississippian, and lowermost Cretaceous sediments. For Jurassic crude oils, thermal methods appeared suitable throughout W Canada. A reverse combustion method was considered most applicable to the crude oil in the McMurray formation. E. N. T.

947. Fossiliferous Palæozoic localities in Mérida Andes, Venezuela. G. R. Pierce *et al.* *Bull. Amer. Ass. Petrol. Geol.*, 1961, **45**, 342–75.—This current study in W Venezuela, with supporting data available from Colombia and Ecuador, indicates widespread deposition during the Cambrian, Ordovician, Devonian, Pennsylvanian, and Permian periods of the Palæozoic era in NW S America. In Venezuela the study of exposures and very limited data available from the wells which penetrated Palæozoic strata indicates that each of the periods of sedimentation, with the exception of the Pennsylvanian, was followed by a period of diastrophism. As a result, only remnants of the original sedimentary deposits are now preserved.

Described herein in detail are 13 marine fossiliferous Palæozoic localities from the Mérida Andes of W Venezuela, together with illustrations and location maps. E. N. T.

948. Geology of parts of Antofagasta and Atacama Provinces, Northern Chile. H. J. Harrington. *Bull. Amer. Ass. Petrol. Geol.*, 1961, **45**, 169–97.—This paper deals mainly with the description of more or less isolated areas of sedimentary rocks along the Atacama Desert between Chanaral and Tocopilla on the coast and between Potrerillos and San Pedro in the E. Pre-Cambrian, Upper Palæozoic, Mesozoic, and Upper Tertiary rocks are displayed in the region. This vast region, nearly 330 miles long and 120 wide, has been visited by few geologists. Large areas formed almost exclusively of volcanic and igeneous rocks, or covered by alluvial deposits, have been only summarily reconnoitred.

The Jurassic and Cretaceous sedimentary sequences exposed at Moctezuma, Caracoles, Potrerillos–Pedernales, Purilactis, Sierra de Almeida, and El Way are described in some detail. The E part of the region is formed of Upper Tertiary continental beds and volcanic rocks. E. N. T.

949. Tectonic framework of Egypt and its influence on distribution of foraminifera. R. Said. *Bull. Amer. Ass. Petrol. Geol.*, 1961, **45**, 198–218.—This paper gives evidence that palæontology can contribute fundamentally to the understanding of the tectonic framework of Egypt. Evidence obtained from the study of the vertical and areal distribution of foraminiferal species in widely separated localities in Egypt has helped in a better characterization and delimitation of the stable and mobile shelves.

The study of the faunal succession of the Upper Cretaceous–Lower Tertiary rocks in Egypt offers the best grounds for contrasting the two structural facies of Egypt. Rock facies of this succession are closely connected with the advance or retreat of the sea in the stable shelf; while in the N these rock facies thin and change their age abruptly in a way that can be explained only by tectonic control. E. N. T.

950. Oil in Africa. 1. Petroleum geology of Libya. C. A. Fothergill. *Petroleum, Lond.*, 1961, **24**, 137.—The paper commences with a general discussion of oil indications and exploration in Africa, and continues with a more detailed description of the petroleum geology of Libya. Exploration was commenced only in 1955, but up to the end of 1960, 12 oilfields were reported, with more than 60 producing wells (potential production *ca* 115,000 bd). The petroleum geology of the W, SE, and E provinces is given in some detail. G. D. F.

951. Geology of Northern Luzon, Philippines. E. F. Durkee and S. L. Pederson. *Bull. Amer. Ass. Petrol. Geol.*, 1961, **45**, 137–68.—Geologically the part of N Luzon N of Lat. 16° N now consists of one well-defined structural basin, the Cagayan Valley, which is circumscribed in part by two mountain ranges, the Sierra Madre and the Cordillera Central.

The basement foundation of Luzon is predominantly of early Tertiary age; most of the sediments accumulated in Miocene and Pliocene time, and are mostly eugeosynclinal. Carbonates seem to be fringing, reefoid types. In late Miocene time the basins ceased to subside, but continued to fill with brackish-water Pliocene sediments which grade upward into fluviatile deposits.

Most of the anticlinal and synclinal trends visible at the surface, fault zones, and stratigraphic units have been named. Type sections are designated and described for the stratigraphic units discussed and mapped. E. N. T.

GEOPHYSICS AND GEOCHEMICAL PROSPECTING

952. Mobile magnetometer gives rapid coverage. W. E. Heinrichs. *World Oil*, March 1961, **152** (4), 82.—There is a trend towards less expensive geophysical methods, and a truck-mounted magnetometer has proved to be a practical tool which provides intermediate detail with speed between that of airborne and manual surveys. It was introduced in 1952, and extensive surveys have been carried out, particularly along open highways in New Mexico. A modified flux-gate magnetometer is used, effects from the truck being minimized by mounting detector and orienting tools in a head at the end of a 20-ft glass-fibre boom. Contoured aerial magnetic data, where available, could be correlated precisely with mobile magnetometer data for certain areas. Exceptions are effects due to differences in exact ground positioning, and greater detail was recorded on the ground because the truck was closer to the magnetic " source." An example of an interpretation of a magnetic survey in NE New Mexico is briefly described. Two refs. C. A. F.

953. New radio reflection method finds oil and gas directly. H. T. Brundage. *World Oil*, March 1961, **152** (4), 54.—A radio wave reflection technique has recently been developed as a means of locating oil and gas fields, and field tests show promising results. Equipment consists of a highly stable, portable radio frequency transmitter and a portable receiver, the output system being adjusted to match the characteristic impedance of the ground. Straight line traverses are run across the prospective area with a min spacing of stations of *ca* 50–100 ft, and it is claimed that radio energy, which can be detected, is reflected at oil–water and gas–water contacts. This is thought to be due to abrupt changes in electrical characteristics of hydrocarbon and salt water. In barren areas the energy is rapidly attenuated. If an accumulation is indicated it can be localized by computation or from graphic diagramming of the radioactive wave response data. Velocities have not proved a problem, and it is claimed that stratigraphic accumulations can be detected as readily as structural, lithology apparently having no effect on the method. The technique would not be suitable in areas covered by blanket bituminous beds. Some recent case histories are noted. C. A. F.

DRILLING

954. Laboratory drilling performance of the full-scale rock bit. D. S. Rowley, R. J. Howe, and F. H. Deily. *J. Petrol. Tech.*, Jan 1961, **13** (1), 71–81.—The lab equipment was capable of giving bit loads up to 50,000 lb, rotary speeds up to 400 rev/min, and torque capacity of 9000 ft-lb, bit sizes ranging $3\frac{1}{4}$–$9\frac{1}{2}$ inches. The dolomite test block was in a chamber capable of simulating borehole and overburden pressure up to 3000 ft depth. Fresh water was circulated. The drilling rate and bit rotary power were expressed as empirical quadratic equations: $R = a + bN + cN^2 + dW + eW^2 + fNW$ and $P = A + BN + CN^2 + DW + EW^2 + FNW$, where R = drilling rate, ft/hr; P = bit rotary power, hp; N = rotary speed, rev/min; W = bit wt, 1000 lb; the remaining terms are constants.

Using $4\frac{1}{2}$-inch bits, added bit weight increased drilling rate and rotary power at an increasing rate: increased rotary speed caused the drilling rate and power to increase at a decreasing rate. The rock vol removed per unit of energy increased as wt was raised or as rotary speed was reduced. The mechanical efficiency of a rock bit is *ca* 30%. Full-scale rock bit efficiency is greater than the efficiency of the micro-bit. G. D. H.

955. Maximum permissible dog-legs in rotary boreholes. A. Lubinski. *J. Petrol. Tech.*, Feb 1961, **13** (2), 175–94.—Fatigue failures of drill pipe and drill-collar connexions, worn tool joints and drill pipe, grooved casing, and key sets can arise from excessive dog-legs. These troubles increase in most cases the greater the tension in the drill pipe at the dog-leg. Hence, the closer the dog-leg to expected total depth, the larger is the acceptable value. Fatigue failures of collar connexions may be worse when rotating off bottom than when rotating with the full wt of drill collars on the bit, especially in highly inclined holes, when the inclination at the dog-leg decreases with depth.

Since inclinometer and directional surveys are generally run inside drill collars, there may be survey errors due to stiffness and position of the drill collar in the holes.

Failure risks increase in corrosive mud conditions. Alternation of stresses on rotation leads to fatigue.

A table gives max change of angle between survey stations for different spacings to avoid drill-collar connexion failures for various inclinations, collar and hole sizes. Because of the cost of surveys it is best to take readings far apart, and if an excessive dog-leg is indicated in some interval intermediate close-spaced readings are taken to ascertain whether remedial treatment is needed. Instruments especially designed for dog-leg surveys are required. G. D. H.

956. Sonic method for analysing the quality of cementation of borehole casings. M. Grosmangin, F. P. Kokesh, and P. Majani. *J. Petrol. Tech.*, Feb 1961, **13** (2), 165–71.—Temp surveys and radioactive materials in cement merely show the presence of cement behind casing, without indicating its hardness or bonding to the casing. Sonic pulses are greatly attenuated when the cement is bonded to the casing. A sonic source and receiver a few feet apart can be used to measure the amplitude of the signal received. Lab studies have shown far greater attenuation with increased spacing when the casing and cement are bonded than when the casing is free, even though surrounded by cement. Removal of longitudinal strips of cement to simulate channelling also increased attenuation.

Field tests have shown increase in bonding with time of setting, the effects of squeeze jobs, and that sometimes these may reduce bonding in nearby cement, that bonding may be less effective opposite pay than against water sand, that inferior bonding may occur where there has been caving, while scratchers may aid bonding.

Production tests have confirmed the indications of poor cement jobs. It appears that bond to the casing is associated with bond to the formation. G. D. H.

957. How to use foaming agents in air and gas drilling. W. C. Goins and H. J. Magner. *World Oil*, March 1961, **152** (4), 59—Surface active agents are being used in air and gas drilling to prevent balling up and to assist removal of cuttings, as well as for decreasing borehole pressure and increasing penetration rate in the presence of water. For max drilling rate the fluid column pressure should be as low as possible, and foam or mist drilling can provide considerable advantages. The circulating system used consists of compressors which provide the high pressure air, and the chemicals are injected into the air stream before the air enters the drill string. Water with corrosion inhibitors and foaming agents is sometimes injected separately, or all the chemicals and water can be pre-mixed before pumping in. On leaving the bit the air–water–chemical mixture flows up the annulus and lifts the formation water, which is deflected at well-head via a blow-line into a pit. Various foam-producing chemicals have been used, and agents which give best results are non-ionic foamers. These are not

strongly adsorbed by cuttings and are satisfactory in salty waters. Field use of the agents is described, together with equipment and air vol requirements. Continued improvement in foam practice, such as more effective agents and greater air vol, have resulted in substantial increases in drilling rates. Most holes do not tend to slough while foaming, but there are hazards in drilling through heaving shales, and water disposal at surface is a problem. 11 refs.

C. A. F.

958. Index maps aid air/gas drilling operations. A. Gibbon. *World Oil*, March 1961, **152** (4), 69.—The rapid and successful growth of air and gas drilling in the Rocky Mountain area of the U.S.A. has led to an extensive survey of drilling operations in the region. Results have been published on a map which is presented. It shows, on a $\frac{1}{4}$-inch scale, the main sedimentary basins extending from the Canadian border into N New Mexico and Arizona. The location of over 250 air and gas drilled wells and the success of drilling operations are indicated.

C. A. F.

959. Drilling fluids in the Rocky Mountain area. H. B. Brown. *World Oil*, March 1961, **152** (4), 74.—Detailed mud programmes have been planned in the Rocky Mountain area to aid contractors and reduce drilling costs. Pays range from Cambrian to Oligocene, and formation fluid pressures are normal or subnormal. High pressure drilling problems are limited to isolated areas, and the major problems are lost circulation, salt and/or anhydrite contamination, and damage to sensitive pays. Drilling problems and mud programmes for the main producing areas of the region are described, and it is shown that the latter will provide lower drilling and completion costs, low mud costs, higher drilling rates, and permit max protection of pay zones. Low solids muds, for example, give major increases in bit life and penetration rate at *ca* the same cost as commercial oil emulsion muds; various types have been used in the region. Inverted oil emulsion and ligno-sulphonate muds have been used successfully.

C. A. F.

960. Techniques of electric log interpretation. E. R. Atkins. *J. Petrol. Tech.*, Feb 1961, **13** (2), 118–24.—A considerable number of assumptions are involved in electric log interpretation. SP may be a combination of electrochemical and electrokinetic potentials. Most interpretations assume the latter to be relatively negligible. Some papers cast doubt on the SP for finding formation water resistivity, but no substitute has been offered. The appropriate resistivity device must be used to get the apparent resistivity of the zone of interest (flushed, invaded, uninvaded). Suitable correction procedures must be used to convert apparent to true resistivity. Empirical relationships link formation resistivity with water saturation. These have appeared in various forms, and one constant may depend on whether the formation is clean, shaly, or oil-wet. Porosity has been empirically related to resistivity. There are variations. It seems best to find the formation resistivity factor from beds 100% saturated with water of known resistivity; its evaluation from data for an oil or gas zone depends on estimates of the flushed zone water saturation. There are many relationships between this and porosity, and the use of a single one on all occasions may give wrong porosity values. The resistivity of the water in a core or formation is not necessarily the same as the flushing water.

G. D. H.

961. Acoustic logging. F. Lebreton and J. Arnaud. *Rev. Inst. franç. Pétrole*, 1960, **15**, 1847–80.—Acoustic logging employs a sonde with an energy source and one or two receivers. The received spacing is 1–10 ft, and the distance from energy source to receiver is 3–10 ft. The hole must contain fluid for measurements to be possible. With cemented tubing, measurements on the rock are possible when the velocity is higher than for steel. Caving and bed thickness affect the records, and the presence of vertical fissures or cavities in the rock may lead to skipped cycles.

Acoustic logging can be used for correlation, making synthetic seismic records, detecting where the tubing is cemented or breaks in the tubing, and, under favourable conditions, for recognizing the fluid content of the rock and estimating porosity.

Porosity measurement is discussed in considerable detail. Many illustrative logs and diagrams are included.

G. D. H.

PRODUCTION

962. Effect of restricted fluid entry on well productivity. F. Brons and V. E. Marting. *J. Petrol. Tech.*, Feb 1961, **13** (2), 172–4.—A formation may be open to production only at the top (partial penetration), in the middle, or in a series of intervals spread over the entire section. The blocking off of parts of the formation leads to impairment of production compared with the case of the whole section being exposed, and this may be treated as a form of pseudo-skin factor. A penetration ratio is defined by the ratio of the total interval open for fluid entry and the total thickness of the productive zone. Numerical studies of the basic equations show that after a short period the pseudo-skin factor becomes of importance. A ratio h/r_w is also involved, r_w being the well radius and h the half-distance between corresponding points in adjacent open intervals. For a penetration ratio of 0·2, $r_w = 3$ inches, drainage radius of 660 ft and $h/r_w = 600$, 300, and 60 for the three types of completion, the loss in productivity was 68, 56, and 11%. Thus a series of intervals open, or the middle open, is better than the same total exposed interval at the top or bottom of the interval. Although the theory is not applicable strictly to perforations, the results support the experience that above a certain density further perforations add little to output. These results apply only to isotropic permeability distribution.

G. D. H.

963. Economically successful miscible-phase displacement project. W. E. Block and R. W. Donovan. *J. Petrol. Tech.*, Jan 1961, **13** (1), 35–41.—A slug-type displacement project was begun in the 29D pool of the Midway–Sunset field in March 1958. The pressure was 1500 psia and the temp 180° F. This is a Miocene stratigraphic trap at 5300 ft, covering 530 acres and originally having $7{\cdot}5 \times 10^6$ stock-tank brl of 31° API oil. Sand fingers of a few inches to 10 ft thickness occur interbedded with shales, and permeabilities vary widely up to 1500 mD. A large secondary gas cap had developed. There are 21 wells. Production was by dissolved gas drive and a limited water drive. Gas injection began in 1956, reaching 1500 Mcf/day in 1957. 780,000 Mcf had been injected when propane injection began, but pressure had dropped during gas injection from 1650 to 1520 psia. Propane injection began at 10,000 gal/day, attaining 52,000 gal/day through two wells in Aug 1959. Propane injection stopped in Jan 1960, and the two wells then received gas, but propane was put into two lower wells in another sand unit. Propane injection totalled 18×10^6 gal in April 1960, and 5×10^6 gal had been produced. The pressure fell from 1520 to 1250 psia during propane injection. The hydrocarbon pore vol is *ca* 2×10^6 gal. It was estimated that max flood-front advance rates of *ca* 0·1 ft/day were needed for stable miscible displacement; average actual rates were 0·5 ft/day. The gas and oil produced have been examined for propane. Five of the 12 current producers have responded to propane injection, and 230,000 brl of additional oil have been obtained. In April 1961 the pool output was 900 bd, 540 bd more than expected from gas injection alone. The additional oil has paid for the additional investment and operating costs of the miscible displacement operation. It appears that substantial amounts of economic oil can be obtained after propane breakthrough.

An ultimate oil recovery of $3{\cdot}8 \times 10^6$ stock-tank brl is expected; primary depletion and gas injection were expected to give $1{\cdot}9 \times 10^6$ and $2{\cdot}3 \times 10^6$ brl. There has been some asphalt deposition in equipment. Propane recycling is planned, and propane is to be extracted on the spot.

It appears that miscible displacement worked with a gas saturation of 31%. G. D. H.

964. Application of optimizing techniques for studying field producing operations. H. D. Attra, W. B. Wise, and W. M. Black. *J. Petrol. Tech.*, Jan 1961, **13** (1), 82–6.—The choice of the best plan for a complex field operation cannot always be satisfactorily made on the basis of judgment and experience. Large field development projects, multi-reservoir producing operations, gathering system, and pipeline design may raise difficulties. Linear programming may then be used to investigate systematically the possible solutions in order to obtain the best answer. For purposes of illustration, a field with four reservoirs and 40 oil and gas wells, three of the reservoirs being produced by gas injection and the fourth supplying some of the gas, has been studied. The field has a four-pressure gathering system and five compressors. The aim is max net income on a day-to-day basis. Formulation of the basic relationships is critical and time-consuming; it must be complete and correct. Subsequently the calculations can be repeated quickly with only the additional field data and altered factors. The programme must recognize that well production cannot exceed max well capacity; gas injection cannot exceed high-pressure compressor capacity; the various gas sources, requirements, and stage compression capacities must be considered, together with gas-lift needs.

An IBM 705 computer was able to handle the specific calculations in 1½ hr. G. D. H.

965. Scale-model study of bottom-water drives. D. H. Henley, W. W. Owens, and F. F. Craig. *J. Petrol. Tech.*, Jan 1961, **13** (1), 90–8.—Scaled lab model tests were made on unconsolidated sands in transparent holders representing a segment of a drainage area under bottom-water drive. The ratio of interwell distance to formation thickness was 12 and 2; well penetrations were 0·25–1, mobility ratios 0·1–10, gravity-to-viscous force ratio 0·05–123, and capillary-to-gravity force ratio 0–22. Visual observation was aided by the use of dyed fluids; an initial interstitial water content was created.

When oil and water were of equal density, and in the absence of capillary forces, the results agreed with previous theoretical studies. At a wide well spacing the oil recovery at a water/oil ratio of 20 varied three-fold according to the properties of the system and the production rate. The greater the well penetration, the greater the total water production to a producing water/oil ratio of 20. Impermeable pancakes at the bottom of a well moderately increased the oil recovery efficiency at water breakthrough and at high water/oil ratios. Horizontal fractures at the top of the formation did not greatly change the sweep characteristics of the models when the radius and fracture capacity were comparable with those of actual reservoirs. Capillary forces have no marked effect on sweep efficiency; gravity effects can be of major importance in performance; low mobility ratios give more efficient recovery performance. G. D. H.

966. Influence of some parameters on the displacement of oil from a porous medium by water. R. Prudhomme. *Rev. Inst. franç. Pétrole*, 1960, **15**, 1575–633, 1768–812.—The displacement of oil by water may be dependent on the permeability, pore morphology, wettability and dimensions of the porous body, on the densities and visc of the oil and water, on the interfacial and adhesion tensions, on the rate of injection, pressure gradient, and initial water saturation. The measurement of these properties and the literature on their influence are reviewed.

The displacement of oil by water flowing upwards through columns of sands of different sizes has been examined experimentally, note being taken of the displacement at water breakthrough. The primary fractional recovery increased somewhat with increase in length of the sand column, but after the sand had been cleaned with chloroform a 10% lower recovery was obtained.

Contact angles have been computed from capillary ascent measurements in sands of two sizes, giving values of *ca* 50° (in the liq or water) for water/air and *ca* 60°–70° for oil/water, the results being most variable for the coarser sand; for oil/air the value was 0°. These measurements take a very long time.

Tests at different rates of flow made on sands that had been cleaned with chloroform showed in some cases the recovery at water breakthrough to have a minimum at a certain rate. The same was true for total recovery, but instances occurred, especially with the coarsest sand, where these conditions did not apply.

When the length of the sand column was varied the recovery increased with increase in length, both for breakthrough and final recoveries.

Washing the sands with water and Teepol gave reproducible wettability, but was slow; washing with toluene and alcohol was quicker and effective. The sand was then water-wet. Recovery *v.* rate results were irregular. Clearly wettability is important.

Tests made on sands which had not been cleaned, apart from washing out fines, and were water-wet, showed a slight max in the recovery-rate of flow plots. All tests were started at the same time after putting the oil in the sand to avoid differences in adsorption of polar cpds. For sand columns over 50 cm long, recovery was independent of length.

Attempts to investigate the effects of variation in oil/water interfacial tension showed no definite trend, and there was evidence that the surface-active agent (sistepal) used to change the values was being adsorbed in passage through the sand.

A sectional tube was used to study water saturations along the sand column. The saturation was highest at the entry, fairly uniform for much of the height, and fell to a low value at the top.

The visc ratio did not affect the final recovery; primary recovery is lower the higher the oil/water visc ratio.

G. D. H.

967. New notching tool improves fracturing. J. L. Pekarek *et al.* *World Oil*, March 1961, **152** (4), 65.—A down-hole notching tool has been developed for preparing a well bore for hydraulic fracturing. It cuts mechanically a V-notch through casing and permits control of the point and place of initiation of a subsequent hydraulic fracture. Details of the tool are given; it consists of cutting blades pivoted about a fixed pin in the tool body. On extending the blades an under-reaming tool is operated for the required footage, but for a small notch it is possible to extend the blades to a pre-determined position using by-pass ports in the tool body. When the plunger assembly which controls the blades is in the proper position for correct extension of the blades fluid circulates through the ports, and this is noted at the surface as a fluid pressure reduction. Diagrams of the equipment are included.

C. A. F.

968. Some results of fracturing with the single-point entry technique. V. N. Swift *et al.* *J. Petrol. Tech.*, Jan 1961, **13** (1), 29–34.—The single-point entry technique requires the borehole to be notched, and a single high-flow-capacity fracture to be made. This was first used in secondary recovery, and to control gas and water coning. It has been employed in primary production. For effective well stimulation the flow capacity of the fractured part of the formation must be ten or more times that of the unfractured part.

Big Piney has produced 496,000 brl of oil from the Mesa-

verde through 32 wells on 1200 acres. The sand has 18% porosity and averages 10 mD permeability. Four conventionally fractured wells had formation breakdown pressures of 1·7 psi/ft; notched wells have 2·5 times the injection rate of the others for an injection pressure gradient of 1·3 compared with 1·2 psi/ft; the propping agent was 8–12 and 10–20 mesh. The conventionally fractured wells pumped 20–25 bd, and the rate rose to 45 bd when bottom-hole heaters were installed. The notched wells gave 700 bd initially, with cumulative production of 130,000 brl for four wells in nine months, whereas the four wells with bottom hole heaters gave 41,800 brl in a similar period. Pressure build-up was quicker in the notched wells.

At Patrick Draw the formation capacity was 320 mD-ft; the notch fracture had a capacity of at least 3000 mD-ft and a radius of 150 ft. Notched and conventionally fractured wells averaged *ca* 700 bd initially, but the productivity indices for the former ranged 0·25–5·7 bd/psi and for the latter 0·17–2·0 bd/psi.

Operations at Bijou at 6150 ft showed the fracturing to be done more readily with a notch than without. G. D. H.

969. Automatic gas well dewatering system cuts costs. M. C. Gillis. *World Oil*, March 1961, **152** (4), 71.—An automatic system for removing water from low pressure gas wells has been developed in the Hugoton area of Oklahoma and Kansas. Three installations are now operating economically and efficiently, and they appear to be adaptable to producing water or condensate from higher pressure gas wells when normal flow rates are too low for conventional liq flow through tubing. The system uses a min of subsurface equipment and comprises a tubing string set near or through the producing zone with a tubing stop and plunger free to move through the tubing. There is a controlled bleed port, which permits small amounts of gas to vent through the tubing, and a differential pressure tripping mechanism which operates a motor valve when the pressure difference between tubing and casing reaches a max set value. A closing mechanism shuts the motor valve when plunger reaches surface. A diagram shows the layout, and details of operation are given. The system provides a simple, maintenance-free, completely automatic field installation. C. A. F.

970. Oil injectivity surveys evaluate well remedial work. R. H. Widmeyer. *World Oil*, March 1961, **152** (4), 51.—Oil injectivity surveys are used for evaluating well remedial work, such as effectiveness of fracturing, acidizing, sand consolidation, and perforating. Results of stimulation treatments and squeeze cementing can be assessed, as well as the location of leaks and channelling. The technique consists of logging the injectivity profile by using a slightly radioactive soln to identify one of two injection streams entering the well. One stream moves down through the annulus, and the other moves upwards via open-ended tubing placed below the zone of interest. A radioactivity detector is used to locate the interface where the two streams meet. The total input rate is held constant, and the percentage injection into tubing and annulus is systematically varied as the depth at which each interface occurs is recorded. Examples of logs are given. Two refs. C. A. F.

971. How to start a water flood. L. J. Hays. *World Oil*, March 1961, **152** (4), 58.—For max profit a water flood must be efficiently and thoroughly planned, and for this purpose a check list is presented which outlines the steps to be considered before installing a flood. This schedule permits various operations to be carried out at once so that work can be completed rapidly at min cost. C. A. F.

972. Review of California water flooding operations. N. van Wingen and B. L. Melkonian. *J. Petrol. Tech.*, Feb 1961, 130–3.—In mid-1960 California had 55 active secondary recovery projects of water flooding, involving injecting 497,895 bd of water through 322 wells. Flooding began in 1944, and rose markedly after refinery requirements began to exceed Californian production in 1952. Water injection at Wilmington is 48% of the state total. Projects which are principally pressure maintenance or water disposal currently involve water injection of 101,000 and 57,750 bd, respectively. A rapid rise at Wilmington in recent years is related to legislation on subsidence control.

The depths of the projects are 500–9300 ft, and the thickness of perforated zones 50–800 ft. The porosities, permeabilities, and oil visc of the projects are comparatively high. Generally attempts have been made to get good reservoir data, and lab experiments have been made together with prediction calculations before pilot-scale injection. Selective perforation and selective injection by means of multiple packers have been used to overcome the problems of great zonal thickness and the accompanying permeability heterogeneity. Surface injection pressures have ranged from gravity flow to 2200 psi, giving sand face pressures of 0·45–1·06 psi/ft. The average of 0·69 psi/ft is low compared with projects elsewhere in the U.S.A. Various factors range: permeability 40–2500 mD; porosity 15–40%; reservoir oil visc 0·7–600 cP; interstitial water 18–51%. G. D. H.

973. Suction-head correction for centrifugal pumps. J. M. Soth, A. Brkich, and H. Stahl. *Proc. Amer. Petrol. Inst.*, 1959, **39** (3), 54–61.—This paper gives the results of suction-head tests conducted with a single-stage centrifugal pump which handles water and butane at various temp. To correlate the data, an analysis was made of the parameters involved. The results of these tests and others which have been published, when plotted against the parameters evolved, showed a reasonable correlation; and that of the common liq, cold water required the most suction head to prevent excessive cavitation. On the basis of this investigation a net positive suction head (NPSH) reduction chart is presented for various liq. (Authors' abstract.)

974. Deep ground bed for casing cathodic protection. J. P. Daly. *J. Petrol. Tech.*, Jan 1961, **13** (1), 16–18.—Severe external casing corrosion has been observed opposite the Dakota sandstone in W Kansas. Casing has failed within a year. Conventional ground bed designs for cathodic protection have drawbacks. On a lease with six producers and a salt-water disposal well, a deep ground bed was provided by 975 ft of 7¾-inch open-hole, passing 75 ft into the Dakota. 775 ft of 3½-inch od J-55 tubing with 200 ft of 3½-inch od fibre-cast tubing slotted at the bottom were cemented in 20 ft of 7-inch surface pipe. 50 2-inch dia, 9-inch Duriclor anodes connected end to end on a cable passing to the surface were installed, inhibited crude in the tubing above the anodes preventing internal current flow to the steel tubing. A small current applied externally to this tubing prevented rapid failure. A 60-amp, 40-v air-cooled rectifier was pole-mounted at the surface. Return current from each well conducted by the flow-lines passes through a control box.

The total cost was $500, and this could have protected 30 casings. Yearly electric power cost is $70 instead of $120/well for shallow individual ground beds. Very low anode-to-soil resistances are possible with a deep ground bed. Conventional shallow beds cost $400–500/well. G. D. H.

975. Constant-pressure gas porosimeter. A. H. Heim. *J. Petrol. Tech.*, Jan 1961, **13** (1), 87–9.—The apparatus consists of sample chamber, ballast chamber, mercury volumeter pump, vacuum pump, differential pressure gauge, and appropriate valves, together with a high-pressure gas cyl. With the system isolated from the atmosphere and gas cyl and the sample in place, a high vacuum is produced. Next, the system with the sample chamber isolated is pressurized with argon at *ca* 1000 psi, the mercury level being adjusted to an

index below the ballast chamber by means of the mercury pump. A sample of the gas is trapped carefully on one side of the differential pressure gauge to serve as a standard. Gas expansion into the sample chamber is allowed, followed by mercury injection to bring the differential pressure gauge to its original balance point. The vol of mercury is the vol of pore space and free space in the sample chamber. A second run without the sample gives the total vol of the sample chamber, and hence the vol of solid in the sample. The bulk vol of the sample is obtained at atm pressure by raising the mercury from an index below to one above the ballast chamber, with and without the sample in that chamber.

Tests gave slightly higher porosities than for water-saturation methods. G. D. H.

976. Reconnaissance of the Lacq reservoirs. J. P. Vacker and G. Ruez. *Rev. Inst. franç. Pétrole*, 1960, **15**, 1751–8.—The upper Lacq reservoir, found at 700 m in 1949, had produced $2{\cdot}2 \times 10^6$ tonnes of oil by the end of 1959. The daily output reached a max of 900 tonnes in 1954 and has dropped to 200 tonnes. The central fissured dolomitic zone when subject to water advance has oil swept from the fractures, but imbibition into the low-permeability zones is required to displace oil. Peripheral low-permeability limestone gives pumping wells.

The deep Lacq gas reservoir is expected to give 20×10^6 m³/day from 23 wells from 1961. The gas has 15% H_2S. The Neocomian and Upper Jurassic carbonate reservoir beneath marls has over 1500 m of closure; the structure is 15 km by 9 km. The reservoir qualities deteriorate on the flanks. Instruments capable of measuring low porosities have permitted calibration curves to be obtained for neutron logging where cores are lacking. Water saturation has been linked with porosity. From these it has been possible to assess the gas-bearing space. In March 1959 the gas in place was estimated as 22×10^{10}m³. Pressure-cumulative production data indicate reserves of $200–260 \times 10^9$m³.

It appeared that the placing and spacing of the wells would not appreciably affect final recovery. G. D. H.

OILFIELD DEVELOPMENT

977. More discoveries needed to meet foreseeable demands. S. Gibson. *Internat. Oilman*, 1960, **14**, 339–42.—It is predicted that by 1975 the world consumption of oil will have doubled, reaching 40,000,000 bd. At this rate known reserves would last until 1980, and a reasonable rate of new discovery would leave the same amount of reserves as at present. Economic conditions will prevent the amount of oil discovered per 1000 sq miles in any other country reaching that in the U.S.A. G. B.

978. Venezuela's oil decline. Anon. *World Petrol.*, March 1961, **32** (3), 39.—There has been a general decline in Venezuelan oil operations over the past three years. In 1960, although production rose by 2·7%, wells drilled declined by 38% and operating rigs were down by 37%. Field parties were only 20% of 1959. Compared to a world-wide production increase in 1960 of 7·7%, Venezuela is declining in status as a major producing country. C. A. F.

979. Link reports on Brazil. Anon. *World Petrol.*, March 1961, **32** (3), 36.—Organized oil exploration has been carried out in Brazil since 1954, and a report on the oil prospects of the sedimentary basins of the country recommends that exploration in the Palæozoic basins be discontinued and that the general oil prospects are poor. Drilling and seismic work has been unsuccessful in finding structures in the Palæozoic basins, and in spite of much drilling in various areas of the country no significant oil reserves have been developed. C. A. F.

980. Oil—new Africa and old concessions. K. N. Goss. *World Petrol.*, Feb 1961, **32** (2), 48.—Out of 17 African states S of the Sahara which had attained independence in 1960, at least six contain major foreign mineral concessions originally granted to colonial powers. It seems that the new states are, however, initially bound by existing concession agreements, but new grants would not necessarily be bound by former conditions. Concession agreements in these states are outlined; they include the Congo Republic and the former French territories. C. A. F.

981. How Soviet gas industry is growing. A. K. Kortunov. *Pipe Line Ind.*, Jan 1961, **14** (1), 41–3.—The Soviet seven-year gas production plan is outlined. The plan includes the laying of 26,000 km of pipeline and an increase of gas production to 150 billion cu m by 1965. The Bashkirian gas field has an estimated size of 200–300 billion cu m and an estimated output of 3,000,000 cu m at the end of 1960. G. B.

TRANSPORT AND STORAGE

982. Oil tanker terminal at Angle Bay. Anon. *Engineer, Lond.*, 1961, **211**, 702–3; *Fluid Handl.*, 1961, 124–32.—Terminal on S shore of Milford Haven. 1220-ft jetty (2300 ft overall with mooring dolphins) with two berthing heads in 55 ft min water each suitable for a 100,000-ton tanker (photo). Shore link 1350 ft long with 16-ft road and 32-ft pipetrack (2×26 inches crude, 3×16 inches bunker, 2×12 inches (diesel and fire-fighting water), 1×10 inches (potable water)). Storage eight floating roof crude tanks at 21,000 tons, + 36,000 tons fuel. Link to Llandarcy refinery (62 miles) is 18-inch line operating at 850 psi (map). V. B.

983. Europoort: Rotterdam's bid as Europe's major oil port. Anon. *Petroleum, Lond.*, 1961, **24**, 129.—The Europoort Plan now under construction in the Netherlands is outlined. The first harbour sites will be accessible for vessels up to 70,000 dw tons with draughts up to 42 ft. The Royal Dutch/Shell and other refinery installations are close at hand; and the Rotterdam–Rhine pipeline also starts from Pernis, which is near by. The oil sites and storage installations in the Europoort project are already complete and are described. G. D. F.

984. Automation for liquid pipelines. J. Stephenson. *Pipe Line News*, Feb 1961, **33**, 29.—The paper is a general and descriptive one dealing with advantages of automation, centralized, satellite, and monitored control. It gives recommendations for future pipeline design based on complete compatibility of control equipment, safety of operation, speed of response, and high degree of reliability and accuracy of control. M. F. M.

985. Computer programme for a heated crude line. D. R. Horner and P. Fried. *Pipe Line Ind.*, 1960, **13** (5), 57–61.—A programme for the IBM 650 computer which can be modified for the IBM series 700 computers is described. The data required include the geometry of the line, the characteristics and locations of pumps and heaters, the thermal props of the surrounding medium, and the quantity and props of the crudes comprising the pumping cycle. The computer reports conditions along the line for different positions in the pumping schedule and the average throughput for the complete pumping cycle. G. B.

986. Computer comes up with answers on pipeline operations. D. W. Dreier and B. A. Sachs. *Pipe Line Ind.*, 1960, **13** (5), 62–5.—A computer programme has been developed to simulate the operation of the Trans-Arabian pipeline from Qaisumah to Sidon. The system is very sensitive to the pattern of ship arrivals and storms at Sidon and to turbine

breakdowns. These factors are generated statistically. Other factors affecting thoughput are derived from engineering calculations and operating rules. The model predicts the pattern and extent of delays to ships and provides information upon which to base decisions about changes in facilities and operating policies. G. B.

987. How new Mid-America LPG line will be operated. M. A. Judah. *Pipe Line Ind.*, 1960, **13** (5), 36–41.—The line contains nine terminals and 13 pumping stations. These are controlled entirely by the dispatcher at Tulsa except in case of faults requiring maintenance. The instrumentation and protective devices are described. G. B.

988. Boosting pipeline flow efficiency. A. W. McAnneny and L. C. Sullivan. *Oil Gas J.*, 13.3.61, **59** (11), 141–8.—A series of tests conducted by Trunkline Gas Co to assess the effect of sand blasting on pipeline efficiency are described. These tests showed that sand blasting gives a cleaner and more efficient pipe than either pigging or in-place coating and that efficiencies of the treated pipe approach to within 3% of the theoretical max. A. D. S.

989. Midwestern construction methods matched with terrain. H. C. Bozeman. *Oil Gas J.*, 13.3.61, **59** (11), 133–9.—Close matching of pipeline to terrain exemplifies Midwestern Gas Transmission Co's new 495-mile, 24-inch dia line from the Minnesota–Canadian border to Marshfield, Wis. The line crosses three distinctly different terrains and combinations of double jointing, external wrapping, and field techniques are used to match the different conditions. It has 80-ft double joints in flat terrain, 60-ft double joints in sand, hills, and rock, and 40-ft joints in marsh areas. Three external coatings protect the line, depending on terrain—polyvinyl chloride tape, petroleum wax, and high-temp and semi-plasticized coal tar enamels. The entire length of pipe is coated internally with epoxy resin paint. A. D. S.

990. Report on Alberta–California gas pipeline system. P. Reed. *Oil Gas J.*, 13.3.61, **59** (11), 110–21.—The Alberta–California gas pipeline is the longest 36-inch pipeline ever laid and is the first undertaking by a major distributing firm for piping gas from beyond the U.S. boundaries.

An outstanding feature of the construction programme is the extensive use of field plants. By double jointing at plants, almost half of the welding and nearly all the coating is done before the pipe reaches the right-of-way. As part of the programme for getting the most for the construction dollar, an effort was made not only to plan for adequate facilities but also to furnish advance information to assist contractors in bidding.

The system has been designed for ultimate export of 1173 MMcfd, and underground storage facilities are being developed to cope with seasonal demand. The current estimates for the capital requirement of this system total *ca* $308 million. A. D. S.

991. Pressure surges in pipelines carrying viscous liquids. W. T. Rouleau. *ASME Trans., J. basic Engng*, Dec 1960, 912.—An analytical solution which includes frictional effects is developed for the pressure occurring in a pipeline when Poiseuille flow is stopped by the sudden closure of a valve. Limitations and deficiencies of past solutions of the same problem have been overcome in the present analysis. It is shown that for most pipelines of practical interest the pressure is given by the sum of four travelling waves multiplied by a time decaying exponential; evaluation is easily accomplished with a few simple slide-rule calculations. The computed pressures are shown to compare closely with experimental measurements. A. T.

992. Double-jointing came long way in '60 and greater progress foreseen for '61. P. Reed. *Oil Gas J.*, 13.2.61, **59** (7), 70–3.—In 1960, 750 miles of double-jointed pipe were used on the Transwestern system, whilst in 1961 this method will be used on a 1400-mile trunk line to transmit gas from Alberta to San Francisco. Three different types of double-jointing plants are being used on this new project—the one-, two-, and three-rack types, and these are described in some detail.

There is growing appreciation of the superior weld quality produced by running the inside bead, this having beneficial annealing effect. Double jointing seems to be most attractive for large pipe of dia upwards from 20 inches and the thicker the wall, the greater appears to be the advantage. A. D. S.

REFINERY OPERATIONS

REFINERIES AND AUXILIARY REFINERY PLANT

993. *Petroleum Refiner* 1960 Process Handbook. *Petrol. Refin.*, Sept 1960, **39** (9), 175–284.—A comprehensive review has been made of refining processes of particular importance to the petroleum industry. All the processes are classified and summarized in the same manner. The applications and descriptions of the processes are given, together with the type of charge and yields of production. The process operating conditions, details of commercial installation, and economics are also reviewed. Details for the reviews were submitted by the companies active in the particular field. M. J. M.

994. More than 50 projects to hike capacity. Anon. *Oil Gas J.*, 20.3.61, **59** (12), 137–41.—Details are given of 45 U.S. and ten Canadian gas processing projects which are planned, under way, or just completed. Among these is one of the world's largest in Kansas, having a capacity of 900 MMcfd. Three new helium extraction plants in Arizona, Kansas, and Texas are also included. A. D. S.

995. How to specify staged-opening type valve trays. F. W. Winn. *Petrol. Refin.*, Oct 1960, **39** (10), 145–6.—The process information required for the specification of staged-opening type valves has been given in table form. M. J. M.

996. Process viscosimeter speeds operation. S. F. Kapff. *Petrol. Refin.*, Oct 1960, **39** (10), 141–4.—The general principles are given of an automatic instrument which is in use for measuring the visc of materials which range from light lub oils to heavy residuals. The oil is supplied at a constant flow rate and temp to a capillary tube, the pressure drop across the tube being proportional to the absolute visc of the oil. M. J. M.

997. Aluminizing resists refinery sulphidation and oxidation. G. F. Tisinai and C. H. Samans. *Proc. Amer. Petrol. Inst.*, 1959, **39** (3), 92–101.—Aluminizing the exposed surfaces of carbon steel, or of low alloy steel selected to resist other operating conditions, such as hydrogen attack, is a relatively inexpensive method of protecting against refinery sulphidation and oxidn. Depending upon the application, calorizing, the hot-dip method, or the metal-spray method followed by a diffusion heat treatment can be used. Certain precautions must be taken during application and subsequent heat treatment to secure a satisfactory coating. Observations on actual refining installations are given along with results of lab experiments simulating conditions expected in refinery applications. (Authors' abstract.)

998. Stresses in clad steels in high-temperature corrosive environments. W. H. Funk. *Proc. Amer. Petrol. Inst.*, 1959, **39** (3), 65–73.—One of the important considerations facing the materials specifications personnel in the petroleum refining industry to-day is the selection of material for pressure-vessel construction. Some of the processes currently in use and others in the design stage will require large vessels to operate under conditions of relatively high pressure and elevated temp ranging from 600° to 1150° F, and to contain media frequently excessively corrosive to carbon or alloy steels. A long history of satisfactory service in various types of application suggests that clad steels have the general characteristics which make them suitable for high-temp refinery conditions. A bimetallic plate material consisting of an austenitic-type stainless steel clad on to a carbon or alloy steel, when used in a pressure vessel, will have a complex stress condition consisting of residual internal stresses plus operating stresses caused by temp and pressure. Experience with vessels in service indicates that this stress situation has not been detrimental when the design has been based on formulæ in "Unfired Pressure Vessels," Section VIII of "ASME Boiler and Pressure Vessel Code." With trends in the refining industry towards higher pressures and temp, and with corrosion resistance a necessity, there is a need for detailed stress evaluation of the clad steels. Physical tests of several types of clad steels on flat-plate specimens and on welded cyl of Type 304 stainless clad into carbon steel were performed. Results of the tests indicate that the ratio of cladding thickness and carbon steel thickness, plus production and heat-treating procedures, affect the residual internal stress condition. The tests support conclusions based on service data that clad steels are good materials for refinery construction. Corrosion resistance of the cladding material is not impaired by the manufacturing processes nor by the service conditions. Good welding procedures which are currently in use do not adversely affect the stress condition or service life. (Author's abstract.)

999. Copper–aluminium alloys. Characteristics and properties for the petroleum industry. (In French.) P. Weill-Couly. *Bull. Ass. franç. Tech. Pétrole*, 1960, 1041–64.—Composition usually 4–12% Al, with up to *ca* 5% each of Mn, Fe, Ni. Physical characteristics of typical alloys given. Corrosion resistance properties outlined. Cu–Al alloys are especially resistant to cavitation. Mechanical properties unaffected by low temp (−200° C). Alloys are weldable. More detailed discussion on use in heat exchangers. Numerous diag and illustr. V. B.

1000. Journal survey of gas-processing plants in the United States. Anon. *Oil Gas J.*, 20.3.61, **59** (12), 106–33.—A new survey of more than 630 existing plants in the U.S.A. shows total capacity has risen to more than 40,529 MMcfd. It includes a plant-by-plant breakdown of throughputs, daily production of various liq, and process methods. Total production has risen to more than 43,468,000 gal/day. A. D. S.

1001. Journal survey of gas-processing plants in Canada. Anon. *Oil Gas J.*, 20.3.61, **59** (12), 133–6.—This plant-by-plant survey of existing facilities in Canada gives total capacity for 50 plants at more than 3117 MMcfd. Liq recovery is reported at more than 1,311,000 gal/day. A. D. S.

1002. The Frisia refinery. Anon. *Petrol. Times*, 24.3.61, **65**, 216–17.—Erdölwerke Frisia AG, whose 30,000-bd refinery at Emden came on stream Oct 1960, is now supplying motor spirit to 70 Frisia filling stations in Germany.

The refinery design is basically very simple. Crude oil comes in to an atm topping unit, where *ca* 65% is taken in the bottoms as fuel oil. A single dist side-stream goes to a 5600-bd cat desulphurizer for upgrading to diesel oil. The tower overheads (up to 360° F) go to a desulphurizer and a 4000-bd Sinclair Baker catformer for upgrading to motor spirit. The process facilities include a crude desalter, LPG washer, and a sour water effluent stripper.

The bulk of the crude comes from the American Independent Oil Co's field in the Neutral Zone, but French Saharan crude may be processed shortly if shown to be technically suitable. A. D. S.

DISTILLATION

1003. Molecular diffusivities in distillation. (In Italian.) A. Paratella. *Chim. e l'Industr.*, 1961, **43**, 251–5.—The phenomenon of thermal dist overlaps with that of contact dist, owing to the different mechanism of heat and mass transfer between the two phases (liq and vapour). To evaluate quantitatively these two processes, mol diffusivities have been considered in some binary systems, previously studied experimentally. The use of mol diffusivities gives a sufficient explanation of the empiric behaviour of efficiency of the overall dist process. (Author's abstract.)

ABSORPTION AND ADSORPTION

1004. Try molecular sieves for successful sweetening of natural gasoline. K. H. Bacon and A. M. Henke. *Oil Gas J.*, 20.3.61, **59** (12), 89–92.—Natural gasoline can be desulphurized and sweetened by cyclic adsorption and regeneration using 13 × mol sieves. Factors affecting the design and operation of the adsorption part of the cycle include sulphur content, temp, space velocity, and column design.

A commercial unit has been designed to sweeten 300,000 gal/day of de-ethanized natural gasoline containing from 900 to 2300 ppm sulphur. A scheme for regeneration of the mol sieves is considered and, although de-activation is gradual, a good recovery in capacity is regained by a periodic augmentation of the regeneration by a controlled burn-off of strongly adsorbed sulphur cpds and hydrocarbons. Preliminary results indicate that the process is non-corrosive and commercially feasible. A. D. S.

CRACKING

1005. Application of systems engineering to a process control problem in fluid catalytic cracking. R. E. Hall and G. K. Tucker. *Proc. Amer. Petrol. Inst.*, 1959, **39** (3), 104–13.—The purpose of this paper is to show the usefulness of the systems engineering approach in solving an important process control problem in fluid cat cracking. To meet the objectives sought for in an improved version of fluid cat cracking, a new concept of reactor temp control was proposed. The proposed scheme was so unlike existing schemes that its performance could not be predicted from past experience alone. There was a clear need for a systematic evaluation of the control scheme. A mathematical model of the reactor temp control loop was devised and analysed using standard techniques of servomechanism theory. The analysis indicated that the system would be stable and would respond adequately to wide ranges of operating changes. Observation of the initial unit operation showed the analysis to be correct in that the system proved to be safe, stable, and easily controllable. The discussion includes the derivation and solution of the mathematical model and interpretation of the results. The report concludes with a generalized discussion of the value of the system's engineering approach for solving process control problems. As the need grows for a more quantitative understanding of process control systems, there will be a parallel growth of the systems engineering approach to solve the problems generated. (Authors' abstract.)

1006. Butadiene production and technical production with Dow catalyst. (In German.) R. J. Harbour. *BrennstChemie*, 1959, **40**, 389–93.—The Dow butadiene process is discussed

briefly with a flow diagram. Dow cat—chiefly Ca–Ni-phosphate stabilized with Cr_2O_3—and the Dow process for producing butadiene from selected C_4-feed have experienced, in later years, a number of important changes, as shown by communicated numerical data. The process is carried out in ten industrial dehydrogenating installations with capacity 355,000 tons/pa. A further sphere in feed composition in the process can be comprehended. R. T.

1007. Selectivity in catalytic conversion of *cyclo*hexane in hydrogen atmosphere. (In German.) M. J. van der Burgt *et al. BrennstChemie*, 1959, **40**, 383–9.—Selectivity of two isomerization cat Ni or Pt on a cracking cat—(87% SiO_2, 13% Al_2O_3) as supporter—and a reforming cat—Pt on Al_2O_3 activated with HCl as supporter—is investigated with simultaneous *cyclo*hexane conversion into benzene and methyl*cyclo*-hexane in H_2 atm, or possible products, *e.g. n* and *iso*-C_5–C_7, etc., according to the scheme presented. Influence of variables: temp, pressure mol ratio H_2 : *cyclo*hexane, through-flow rate in the reactor is followed. Thermodynamically derived equilibria are set in relation to this. The hyperbola method is applied in this case for studying selectivity, thus deepening insight into the occurring processes. Decline in cat activity is noticed in some cases. The most important results are presented graphically. 21 refs. R. T.

1008. Platforming of naphthas from Saharan crudes. (In French.) V. E. Henny. *Bull. Ass. franç. Tech. Pétrole*, 1960, 989–1004.—Owing to low S content, Saharan naphthas can be Platformed to 95 F_1 clear without pre-treatment (Unifining) and without recycle gas treatment. Compared to Middle East feedstocks reformate yield is up, gas yield down, space velocity and temp decreased, recycle rate less, cat life longer, but load on inter-heaters greater. Hassi-Messaoud crude yields excess light gasoline and a heavy (155°–180° C) naphtha, for which an outlet would need to be found. Reforming of Saharan feed doubles the aromatics (BTX) yield as compared with ME feed, H_2 yield is also up. Tabulation given of results of Platforming, and TEL response, of feeds from H-M, Zarzaitine, and Edjeleh crudes.
(Author's summary.)

HYDROGENATION

1009. New thermal process makes cheaper benzene. Anon. *Oil Gas J.*, 6.3.61, **59** (10), 80–1.—A thermal hydrodealkylation process (HDA) developed by Atlantic Refining Co gives yields of benzene and naphthalene in the range 96–98% of theoretical. Feedstocks for benzene production may be toluene, xylenes, ethyl benzene, or thermal gasoline. For naphthalene production, cat cracking cycle stocks, heavy reformate, or thermal cracking polymers can be used. Operating conditions include reactor temp in excess of 1200° F, and pressure ranges from 500 psig upward. Hydrogen consumption in benzene production is *ca* 1400 cu ft/brl of toluene charge. It increases to *ca* 1900 cu ft/brl when naphthalene is produced from light cycle stock.

In addition to the higher conversions offered, other advantages claimed are lower plant costs, elimination of cat costs and losses, and low hydrogen consumption. A plant flow diagram is given. A. D. S.

1010. New Crown Central benzene unit will have high conversion efficiency. D. H. Stormont. *Oil Gas J.*, 13.3.61, **59** (11), 182.—A new 17 million gal pa benzene plant, scheduled for completion mid-1961, will be the first application of a new fixed-bed cat dealkylation process developed by Houdry Process Corpn. The process, termed "Detol," is highly selective and produces close to theoretical yields of benzene from toluene, xylene, and other alkyl benzene fuel stocks.

The charge, together with a hydrogen-containing gaseous stream, is heated in the reactors to 1000°–1200° F and at pressures of 500–1500 psig and passed over the cat. The benzene and unconverted alkyl benzenes are condensed and transferred to a high-pressure flash drum. Liq from the drum is stabilized to remove materials lighter than benzene and pumped to a fractionator, from which specification benzene is removed overhead. The bottoms are further dist to separate unconverted alkyl benzenes, which are then recycled.

Estimated operating costs are approx 1·63 c/gal of charge. Capital investment and royalties add *ca* 2·8 c/gal to these costs. A. D. S.

ALKYLATION

1011. New design boosts alkylate quality. W. F. Vernon and C. E. Baechler. *Oil Gas J.*, 20.2.61, **59** (8), 120.—A new HF alkylation unit, now on stream at Phillips Petroleum Co's Kansas refinery, incorporates some of the latest thinking in plant design. Significant features of this 6000-brl motor-fuel unit include a newly developed reactor–settler system which improves alkylate quality and greatly reduces production of acid-soluble oils; operation at an *iso*butane olefin ratio of 15 : 1 and the operation in parallel of the depropanizer and de*iso*butanizer. A flow diagram of the unit is presented, together with typical charge stock and composition and properties of the debutanized alkylate. A. D. S.

1012. Smog control decrees less olefins in gasoline. M. J. Fowle *et al. Oil Gas J.*, 6.3.61, **59** (10), 130–5.—As the pressure for smog control grows, refiners may well be forced to limit the amount of olefins in gasoline. Faced with this prospect, Atlantic studied the effects such a move would have on processing and its cost. Results of this study showed that the major contributor to gasoline-pool bromine number is cat naphtha. Olefins from this source can be minimized by using a silica–alumina rather than a silica–magnesia cracking cat. Either hydrogenation or alkylation of cat amylenes and hexenes will cut olefins by 8–10 bromine number. Alkylating propylene will reduce it by another 3–4 bromine numbers, if this material has been finding its way into the gasoline pool by polymerization. Cost of removing cat amylene and hexene by hydrogenation amounts to *ca* 4 c/brl of gasoline. It costs 16–18 c/brl by alkylation under the conditions assumed in this study. To these costs must be added a capital requirement of *ca* $50 or $100/daily brl of crude capacity. Cost of cutting olefins 13 bromine numbers is 9–12 c/brl of gasoline plus *ca* $150 capital/daily brl of crude refined. A. D. S.

CHEMICAL AND PHYSICAL REFINING

1013. Autofining studies with model compounds. W. J. Hendriks *et al. J. Inst. Petrol.*, 1961, **47**, 88–98.—The autofining studies were carried out on model cpds in a flow reactor containing a fixed bed of cobalt oxide–molybdena–bauxite cat. Feedstocks were composed of a hydrogen donor (decalin or tetralin), a sulphur cpd (dibenzothiophene), and a diluent (benzene). A cycle oil fraction was also desulphurized by autofining, decalin being used as a hydrogen donor.

It was concluded that this cat is active for both the hydrodesulphurization of sulphur cpds and the dehydrogenation of six-membered ring naphthenes into aromatics. An important side reaction in the conversion of naphthenes is the isomerization of six- into five-membered rings. In autofining, this isomerization reaction can be considered as a waste of part of the hydrogen which is potentially available in the feedstock.

The type and quantity of feedstock naphthenes dictates the operating conditions. Low naphthene feedstocks can be processed only under relatively severe operating conditions. If it is desired to operate the process at the higher pressures which prevent rapid decline of cat activity the naphthene content of the feedstock should be high. If necessary, this can be achieved by adding a naphthene containing oil fraction

to the feedstock, but this will result in an unfavourable hydrogen balance. A. D. S.

SPECIAL PROCESSES

1014. H-oil process treats wide range of oils. M. C. Chervenak *et al. Petrol. Refin.*, Oct 1960, **39** (10), 151–6.—A detailed description has been made of the H-oil process and pilot plant data, obtained from units varying in size from 1 gal/day to 25 bd, is discussed. The process is adaptable to heavy residuums and light gas, resulting in a reduction of sulphur and metal contents and an increase in specific gravity. Possible applications for the H-oil process have been suggested. M. J. M.

1015. Keyes plant makes helium at average cost of $9.11 per Mcf. W. M. Deaton and R. D. Haynes. *Oil Gas J.*, 20.3.61, **59** (12), 101–5.—The Keyes plant processes 2% helium-bearing natural gas by a low temp process involving two steps. The first separates a crude helium product from natural gas and the second purifies crude helium to a high purity product. The high purity Grade A helium is shipped to customers in specially constructed rail tank cars at 2100–3675 psig.

The plant has a natural gas processing capacity of 70 MMcfd at a pressure of 450 psig. During the 1960 fiscal year it operated *ca* 330 days and produced 263 MMcf of helium at an average cost of $9.11/Mcf. A. D. S.

1016. Petrochemicals, big and getting bigger. T. L. Cubbage. *Oil Gas J.*, 27.3.61, **59** (13), 114–20.—Petrochemical production has now increased to more than 22 million tons pa, and constitutes 30% of all chemicals by vol. By 1965, they are expected to reach a 40% level. Approx 3000 different chemicals are derived from petroleum and, in this article, discussion is limited to four groups of chemicals—plastics, synthetic rubber, aromatics, and ammonia.

In the field of plastics, three groups—polyethylene, the polyvinyls, and the polystyrenes—account for the major part of total consumption. Polypropylene, the newest of the large-vol plastics, is also considered.

The synthetic rubber industry has grown to 1 million tons pa, two-thirds of all rubber used in the U.S.A. being synthetic. The various types of synthetic rubber are briefly considered.

Production of benzene, toluene, and the xylenes from petroleum represents 62% of total U.S. production of basic aromatics. Half of this production is used as building blocks for more complex end-use cpds.

The U.S. synthetic ammonia production reached 364,000 short tons/month in 1959, as compared with 220,000 short tons/month in 1954. The reason for this increase is due primarily to the rapidly expanding fertilizer market. A. D. S.

METERING AND CONTROL

1017. How catalyst test service aids fluid unit operations. Anon. *World Petrol.*, Feb 1961, **32** (2), 45.—A cat testing service has been set up in the U.S.A. which is aiding process performance. It consists of a programme of periodic lab evaluations of the equilibrium cat in the fluid units. Chemical, physical, and cat properties which affect performance are evaluated, and from these data the history of the use of the cat in a given unit can be assessed and the refiner advised of any necessary changes in his operations. The service is particularly valuable for the small refiner, acting as an adjunct to his process control lab. C. A. F.

1018. Phillips speeds up asphalt service. K. W. Brooks. *Oil Gas J.*, 27.3.61, **59** (13), 111–13.—Automatic blenders for RC and MC cutback asphalts have been installed at four of Phillips Petroleum Co's refineries. Basically, all four installations are the same. Asphalt base is supplied to each blender from storage by a separate pump. Rate of flow of asphalt is controlled by a three-way flow control valve ahead of the asphalt base meter. MC and RC diluents are pumped to the blenders with centrifugal pumps over separate lines. Before loading, recirculation of both base and diluent is set up through the blender so that the correct amounts are flowing through the meters. When loading, the base and diluent combine in the loading line and the blended material goes through an orifice line mixer and meter to the receiver. The temp and visc of the blends are recorded.

Asphalt service is thus speeded up by using these blenders so that cutback asphalts are available immediately on call. A. D. S.

PRODUCTS

CHEMISTRY AND PHYSICS

1019. Effect of ionizing radiations on hydrocarbons. (In French.) A. Chapiro. *Bull. Ass. franç. Tech. Pétrole*, 1960, 971–85.—Lecture. General interaction of radiation and matter discussed followed by description of changes occurring on radiolysis of satd hydrocarbons. Possible reaction mechanism suggested from standpoint of reactivity of free radicals and of ions. Consideration of irradiation of macromolecular long chain hydrocarbons leading either to cross linkage (polyethylene) or chain rupture (poly*iso*butylene). 20 refs. (Author's summary.)

1020. Molecular sieves as aids for refining. (In German.) P. W. Sherwood. *BrennstChemie*, 1959, **40**, 354–8.—Mol sieves consisting of synthetic cryst Na–Ca–Al-silicates, after separating their H_2O of hydration, are noted for their marked selective absorptive power; on the basis of mol size, saturation, and polarity sharp separations can be carried out. Introduction possibilities are treated for gas and liq drying, CO_2 separation from C_2H_4, separating hydrocarbons of different types which, in natural gasolines and reformates, leads to ON increase. For separating S-cpds from natural and synthesis gases, for washing acetone recovery from a C_2H_4 stream, also for enriching C_2H_4. Uses in hydrocarbon analysis are also mentioned. 14 refs. R. T.

1021. Viscosity relations of homologous hydrocarbon series. IV. Physical properties of β-(*n*-alkyl)-naphthalenes and *p*-(*n*-alkyl)-diphenylenes. (In German.) H. Kölbel *et al. BrennstChemie*, 1959, **40**, 281–5.—Dependence of visc properties on chem constitution (chem branchings, aromatic ring introduction, position isomerism) is known qual but not quant. For investigating the connexion between physical properties and chem constitution also producing alkylaryl-sulphonates homologous series of β-(*n*-alkyl)-naphthalenes and *p*-(*n*-alkyl)-diphenyls with even number of 4–16 or 14 C-atoms were prepared. Mp, bp, *d*, and *n* of the hydrocarbons and the corresponding alkyl-naphthyl- and-diphenylketones are discussed. Visc and visc–temp behaviour in dependence on mol size and the structure of the aryl rest are discussed in comparison with the *n*-alkylbenzenes. 11 refs. R. T.

1022. Synthesis and physical data of some *iso*paraffin series with 11 to 24 C-atoms. (In German.) E. Terres *et al. BrennstChemie*, 1959, **40**, 279–80.—Knowledge of physical data—available formerly only for *iso*paraffins with chain length up to 10 C-atoms—is required for identifying *iso*-

paraffins occurring in mineral oils. The gap is filled in by producing and measuring the physical data of *iso*paraffins up to C 24. R. T.

ANALYSIS AND TESTING

1023. Radiometric absorption analysis. I. Possibilities of chemical elementary analysis with a methane through flow counting tube as ray detector. (In German.) L. Wiesner. *BrennstChemie*, 1959, **40**, 273–8.—A process is described (apparatus illustrated) for elementary analysis by measuring the absorption of radioactive rays, in which a methane throughflow counting tube serves as ray detector. Advantages over the Müller–Geiger-counter are discussed fully. By measuring the absorption of radioactive rays, samples containing a large number of elements can be analysed. The procedure is used for quant estimation of H_2, O_2, P, S, Cl_2, I_2, and Pb. A report is presented on practical experience with the analytical procedure and its economical industrial advantages. 11 refs. R. T.

1024. Analytical estimation of water in brown coal and brown coal low-temp coke by drying by high frequency heating. (In German.) J. Jandasek. *BrennstChemie*, 1959, **40**, 309–14.—H_2O estimation in lignite and low-temp coke by high frequency heating is described. Using a frequency of 17 cycles/sec and voltage 3–6 kV, val agree with those of the xylene dist. Estimation of the H_2O cont in the fuel is accurate, requires no chemicals, and involves no oxidn risk during drying. The method avoids long throughput time and—compared with the xylene method—is simpler and avoids use of aromatic hydrocarbons. The method is suitable for series estimations of H_2O cont and is economical for industrial use in time and materials. 20 refs. R. T.

1025. Contribution to the quantitative exact estimation of anthracene. I. Chlorobenzene distribution method. (In German.) E. Funakubo *et al. BrennstChemie*, 1959, **40**, 377–83.—The anthracene estimation method depends on use of the Diels–Alder reaction, and is superior to the former conventional Höchster standard method. A basic fault of the Höchster method is the impossibility of estimation in presence of anthraquinone. Other faults are discussed. The authors present a series of basic investigations on the addn reaction between anthracene and maleic anhydride, on the properties of the adduct, and thereby the—formerly unobserved—important discovered factors of the investigation method. The new perceptions have led to the new chlorobenzene-distribution method described. R. T.

1026. Two new instruments for measuring the air content of oil. A. T. J. Hayward. *J. Inst. Petrol.*, 1961, **47**, 99–106.—Two new instruments for measuring the air content of mineral oil employ the same basic method. A sample bottle filled with oil is sealed with a valve and connected to a sealed chamber. This chamber is evacuated and the pressure measured. The oil is admitted to this chamber and deaeration occurs, with a consequent rise in pressure. The air content of the oil is then calculated from this pressure rise and the ambient temp. The sample bottles, which are of special design, are fully described with diagrams.

Both instruments are simple in construction, robust, and easy to operate. The one which features a vibrating stirrer is very rapid in action and is considered to be more suitable for general use. The accuracy of an individual measurement is within $\pm 3\%$ for both instruments. A. D. S.

GAS

1027. Some technical and practical aspects of the use of LPG in industry, especially in metallurgy and ceramics. (In French.) J. P. Liotier. *Bull. Ass. franç. Tech. Pétrole*, 1960, 1007–38; 1961, 75–112.—Review. Despite high cost per therm, propane is economic if full advantage of its capabilities is taken. Design of LPG burners is considered and technique of slow and rapid heating explained. Advantage of direct heating with naked flame is pointed out; in annealing furnaces where heat transfer rate is low (5–8 kcal/cm²/hr) induced draught burners are suitable. Forced draught burners can give 25–30 and, with simple equipment, 90 can be attained. Diagrams and illustrations.

(Author's summary.)

1028. Middle East seeks ways to use surplus gas. Anon. *Oil Gas J.*, 13.2.61, **59** (7), 95.—*Ca* 25% of Middle East gas is reinjected to help maintain reservoir pressures, 8% is used as a fuel, and the residue is flared. Since it is estimated that 750 MMcfd of gas will be produced there in 1961, there is a great need to find a useful outlet for it. The construction of a large power plant to provide cheap electrical power for new industries has been put forward, and this plan further calls for establishing facilities to make products that are at present imported. Finally, it is suggested that products such as fertilizer and carbon black should be produced for export.

A. D. S.

ENGINE FUELS

1029. Flow properties of ATK at low temperatures. S. C. Dodson and A. G. C. Fairman. *Engineer, Lond.*, 1961, **211**, 499–503.—Work on measuring low temp behaviour of aviation turbine kerosine in rig representative of aircraft fuel system and to find lab test reproducing rig results. Rig layout shown; flow rate little affected by temp until limiting value (−45° to −65° C) of latter reached, when sharp drop shown. Mesh size of booster pump screen not significant, but fuel head is. Five lab tests tried (IP 15A, 15B, 16, 54, ASTM D1477), best rig correlation with pour (IP 15B) but tested at 1° F intervals. New test developed, "Laboratory Pumpability Test" in which 10 ml fuel progressively cooled till no fuel movement with pressure of 20 mm Hg; excellent agreement with flight plan test rig results. Relationship between IP 16 results and yield of ATK given for Kuwait crude; also study of build-up of solidified fuel in aircraft tanks. V. B.

1030. How to blend for volatility. G. H. Unzelman and E. J. Foster. *Petrol. Refin.*, Oct 1960, **39** (10), 109–40.—Hot and cold weather problems associated with fuel volatility requirements for the motor engine are reviewed in this article. Non-seasonal problems, such as engine acceleration, fuel economy, evaporation losses, crankcase oil dilution, engine cleanliness, and octane maldistribution are summarized. Details are given for methods of predicting the volatility and anti-knock properties of gasoline blends. M. J. M.

1031. Kerosines and agricultural fuels. The jet fuel problem. (In Spanish.) V. G. Aranda. *Combustibles (Zaragoza)*, 1960, **20**, 3–16.—Lecture. Tabulation of U.S.A., U.K., French, Spanish jet fuel specs. Bibliog.

GAS OIL AND FUEL OIL

1032. The effect of activated charcoal on the cloud point, pour point, and sulphur contents of gas oil. F. A. Inkley and A. E. Standage. *J. Inst. Petrol.*, 1961, **47**, 120–7.—A typical gas oil from a Middle East crude was selected for this investigation and was either used as received or treated with silica gel to reduce the aromatic content. The oil was forced slowly through a compacted column of untreated activated charcoal in order to reach adsorption equilibrium, and a continuous series of samples was taken. Cloud and pour points were determined by micro-methods, and both total and mercaptan sulphur contents obtained using standard methods.

It was concluded that certain hydrocarbon types are selectively adsorbed which can produce either a raising or lowering of the cloud point, depending on the proportion of aromatic types present. An oil of high aromatic content, after treatment with charcoal, shows an increase in cloud and pour points, whilst one of low or negligible aromatic content shows cloud and pour point depressions. Total and mercaptan sulphur contents are reduced after treatment, particularly when the gas oil is driven under air pressure through the charcoal. A. D. S.

1033. Low temperature flow properties of residual fuel oil: Report of IP Fuel Oil Flow Panel. *J. Inst. Petrol.*, 1961, **47**, 57–73.—The Fuel Oil Flow Panel, set up in Dec 1949, set itself the task of devising a lab test for predicting the lowest temp at which a residual fuel oil in normal commercial storage may be pumped at an economical rate under typical conditions of handling in practice.

The Panel supposed that a suitable pumpability test would consist essentially of two parts: (1) a thermal pre-treatment of the oil sample to simulate the effects of practical storage conditions; (2) an estimation of the mobility of the pre-treated sample at different temp under a shearing stress related to the mechanical conditions applying in practice.

Field data indicated that a shearing stress of *ca* 300 dynes/cm² would be suitable and that the thermal pre-treatment of the IP upper pour point method should induce in an oil a condition similar to that reached under practical storage conditions. Subsequently it was found that the value of the IP upper pour point depended on the age of the sample, and therefore the proposed pre-treatment would not be a reliable guide.

In investigating this further a number of difficulties were encountered, and the Panel decided to make a report before proceeding further with this investigation.

In reviewing the work it was realized that it had not been established that this change in pour point was necessarily reflected in an appreciable decrease in oil mobility, when tested under practical shearing stresses. It was therefore recommended that the effect of age of oil on its mobility after heat treatment should be investigated before deciding whether the general problem of a pumpability test should be pursued.
A. D. S.

1034. Atomizaticn of liquid fuel for combustion. P. Eisenklam. *J. Inst. Fuel*, 1961, **34**, 130–43.—Atomization in a liq fuel combustion system is considered as a mass transfer operation, and the factors influencing the rate of evaporation of drops and sprays are discussed. The formation of drops is considered in terms of the instability of sheets of liq from fan-spray pressure atomizers, and the shatter and coalescence of drops of liq in the spray.

Atomizing devices are grouped according to the primary source of energy employed to achieve disintegration. Pressure, rotary, and twin-fluid atomizers are described. The performance of atomizers is assessed by three major criteria—liq flow-rate, spatial configuration of the resulting spray and its mean drop size, and size dispersion. Methods of drop size determination and analysis are detailed.

The initial drop size at the point of disintegration from the sheet depends on the atomizer type and design of nozzle, the physical properties of the liq, and that of the ambient atm. The performance of sprays using both pressure and twin-fluid atomizers is considered. A. D. S.

LUBRICANTS

1035. Synthetic lubricants for gas turbines. J. S. Elliott and E. D. Edwards. *J. Inst. Petrol.*, 1961, **47**, 39–52.—A brief historical review is given of the development of synthetic gas turbine lubricants in the U.K. and U.S.A. The test methods used in their evaluation are discussed with particular reference to load carrying ability and oxidn stability.

The oxidative mechanism of phenothiazine in synthetic bases is considered, and it is shown that the high insolubles contents and consequent sludging obtained with such oils is due to the formation of insoluble phenothiazine oxidn products. Use of phenothiazine derivatives with longer alkyl side chains resulted in soluble oxidn products but a poorer anti-oxidant performance. A combination of alkyl phenothiazines with other anti-oxidants showed synergistic effects. In consequence, a diester-based lubricant has been developed which complies with D.Eng.R.D. 2487 and contains a chlorine cpd as a load carrying additive and a combination of three anti-oxidants selected to give minimum sludging tendencies with max anti-oxidant effect.

For supersonic aircraft, it will probably be necessary to select more thermally stable base fluids and a number of materials including hindered esters are briefly considered.
A. D. S.

1036. Lubrication of rear axle gears of modern automobiles. (In Spanish.) E. P. Cunningham. *Combustibles* (*Zaragoza*), 1960, **20**, 27–35. Lecture to ASLE, Los Angeles, 17 Feb 1960.

1037. New threat to lubes—the "greaseless car." G. T. Kinney. *Oil Gas J.*, 20.2.61, **59** (8), 84–5.—It is forecast that in the 1963–65 period the "greaseless car" will become standard in the U.S.A. The term "greaseless" is really a misnomer, because it is being applied to cars which do not require frequent greasing of suspension and steering-linkage bearings because these are pre-lubricated at the factory with a molybdenum disulphide grease said to be adequate for 30,000 miles running. Bearings are sealed with plastic and rubber, and cars must be returned to the dealer for greasing with a special gun. Nevertheless, in the passenger car market alone grease consumption is expected to decline from 120 to 40 million lb annually. Oil company automotive engineers have, however, issued a warning that if longer lubricant service intervals become an excuse for neglect of routine inspections, expensive mechanical failures can result. A. D. S.

BITUMEN, ASPHALT, AND TAR

1038. Research commission on mechanical tests. Performance and value of the mechanical tests resting on DIN 1996 for bituminous masses for road building. (In German.) P. Herrmann and A. Scheurer. *Bitumen, Teere, Asphalte, Peche*, 1959, **10**, 244–53.—Mechanical tests, bulk density, pressure, and impact bending strength provide the possibility—without intensive chem investigations—when necessary, within a few hours, of giving relevant decisions on the qual of hard poured asphalt, linoleum-poured asphalt, and asphalt-fine-concrete. On large constructions errors can be rectified before adverse effects appear. Chem determinations strengthen the results. Results of tests are tabulated.
R. T.

1039. Mud concrete—a new foundation process. (In German.) R. Ruck. *Bitumen, Teere, Asphalte, Peche*, 1959, **10**, 254–61.—Importance of the foundation structure for preserving the road surface is discussed. A modern foundation must possess the following properties: it must be firm and load-distributing by grain gradation or by cementing with binder; it must be incompressible so that no after-compression can occur under traffic. It must be insensitive and as impermeable as possible to moisture, and flexible, in order to co-operate in small deformations underground. It must be homogeneous, *i.e.* the supporting stratum shall have the same properties throughout. Mud concrete—which fulfils these requirements—consists of 5% mud concentrate (binder 50 pt, filler 50 pt, H_2O 30 pt)—and 95% graded stone

mixture. Details are given of preparation, cube testing, transport, and application, with illustrations. Tests on mud concrete containing broken minerals, also natural sands and gravel, are tabulated. Test stretches on highways are illustrated and discussed. R. T.

1040. Newer hydrocarbon recovery from high-boiling portions of coal tar. (In German.) K. F. Lang, H. Buffleb, and E. Schweym. *BrennstChemie*, 1959, **40**, 369–70.—Conventional tech pitch dist comprise initial material for this investigation. Dist are fractionated carefully, separated with molten alkali, and treated with maleic anhydride. Isolation of the following cpds is discussed: 1,2,3,4-dibenzanthracene, 1,2,5,6-dibenzanthracene, 1,2,7,8-dibenzanthracene, 3,4-benztetraphene, pentaphene, and *o*-phenylenepyrene. The dist apparatus is described. Nine refs. R. T.

DERIVED CHEMICAL PRODUCTS

1041. Ethylene, fundamental raw material of the petroleum chemicals industry. (In Spanish.) R. U. Lacal. *Combustibles* (*Zaragoza*), 1960, **20**, 17–26.—Lecture.

1042. Versatile chlorinated hydrocarbons. R. K. Treichler. *Oil Gas J.*, 6.3.61, **59** (10), 112–14.—Annual production of chlorinated hydrocarbons in the U.S.A. was *ca* 3·25 million lb in 1960. Based on new uses and new products, this is expected to increase to 4·5 million lb by 1970. An example of a chlorinated hydrocarbon which has tremendous growth prospects is allyl chloride used in the manufacture of epoxy resins. Polymeric fluorocarbons such as Kel F and Teflon, which are based on chlorinated hydrocarbons, are also expected to show wider application. A. D. S.

1043. Petroleum chemicals network of the lower Seine. (In French.) Anon. *Chim. et Industr.*, 1961, **85**, 15–26.—Two refineries (CFR at Gonfreville, 6·6 × 10^6 tons pa, Esso at Port Jérome, 4 × 10^6; scope outlined), both produce petroleum chemicals and supply raw materials to a number of other companies. CFR to Manolène (low pressure polyethylene), Pétrosynthèse (dodecylbenzene), Orogil (lub additives). Esso to Nobel-Bozel (S), Socabu (butyl rubber), Sida (acetone derivatives). Inter-linkage, both commercial and physical, of the companies and refineries is described; outline of processes, photos. V. B.

1044. Italian chemical industry developing rapidly. G. Ballabio. *Internat. Oilman*, 1960, **14**, 307–8.—The status of the Italian chemical industry is described with special reference to the international position of Montecatini as a producer of petrochemicals, particularly plastomers and elastomers, from natural gas. The industry satisfies home needs and exports products, plant, and patent rights. G. B.

COAL, SHALE, AND PEAT

1045. Lean coal coking with oily additions. (In German.) D. Mirew and D. Ruscew. *BrennstChemie*, 1959, **40**, 289–93.—Experiments on a large number of coals of different origin show that oily addn favours agglomeration and swelling of coke. Additions which promote loosening and dispersion effect the strongest increase of the plastic zone. Density of the plastic zone of the coal–oil mixture is approx proportional to the plasticity of the original coal. With increasing oil addn *d* of the plastic zone increases also up to a definite max, then again decreases. Addn of 10% oily material leads generally to a coke with considerable crack formation and decreased strength. Results of coked box samples under industrial conditions show that a 5% masut addn to vac soft asphalt, coal tar, and coal tar pitch doubles its pressure and drop strength, and contributes to conversion of a conglomerate coke structure into a more homogeneous one. 16 refs. R. T.

1046. Chemism of coking investigated on polymeric coal model materials. III. Model material synthesis. (In German.) P. M. J. Wolfs, D. W. van Krevelen, and H. I. Waterman. *BrennstChemie*, 1959, **40**, 215–19.—Model material synthesis from aromatic cpds and formaldehyde is discussed. Using radioactive formaldehyde, it is possible radiochemically to follow the synthesis chemism. A tabulation shows clearly how the radiochem method is applied in practice for structure determination. Pt A shows details of the added reagents: anthracene, standard activated and inactivated paraformaldehyde. Pt B gives an inventory with data of products obtained. Cat ($ZnCl_2$ in acetic acid) is shown to give no undesirable side reactions. Further, it is shown that all the introduced formaldehyde mol, after heating to *ca* 225° C, change into CH_2-bridges. An extensive discussion of the results follows. 13 refs. R. T.

CORROSION

1047. Petroleum industry fights corrosion. Anon. *Petroleum, Lond.*, 1961, **24**, 145.—This article consists of brief reviews dealing with recent developments in fighting corrosion, including the use of epoxy pipes, "Hypalon" synthetic rubber coatings, protecting tanker oil tanks, a gas freeing system in tankers which provides a degree of corrosion control, plastic pipes, *in situ* cleaning and coating of pipelines, anti-corrosive lub oils, a new laminated anti-corrosion lining, and various coating materials. G. D. F.

1048. Corrosion in oil refinery equipment. Anon. *Petroleum, Lond.*, 1961, **24**, 142.—Abstracts are given of two papers to be presented at the First International Congress on Metallic Corrosion, London, 10–15 April, one dealing with the reduction of corrosion in steel pipes carrying sea water, and the second with the prevention of corrosion of refinery equipment by hydrochloric acid, sulphur, sulphur dioxide, sulphuric acid, hydrogen, and caustic soda. G. D. F.

1049. Tackling corrosion in boiler water systems. T. B. Fielden. *Petroleum, Lond.*, 1961, **24**, 143.—When water for cooling is recirculated, scale and corrosion problems become acute. Some recent techniques for dealing with such problems are outlined. Some recent non-toxic inhibitors are mentioned. The corrosion problems in steam generation equipment are reviewed, together with recent developments in this field. G. D. F.

1050. Lower, less-variable power needs favour deep ground beds. J. P. O'Donnell. *Oil Gas J.*, 20.2.61, **59** (8), 117–19.—Deep ground beds, in a majority of cases, provide a more satisfactory method of cathodically protecting bare pipelines than conventional beds. Probably the greatest single advantage of the deep ground bed is its lower and less variable use of power, because of its location in low-resistance soil. A further advantage is that less extensive soil surveys are needed in locating such beds. The method of installation of such beds as employed by Interstate Oil Pipe Line Co is detailed.

Although installation costs of deep ground beds are higher than for conventional ground beds, these are offset by lower operating costs. A. D. S.

1051. Test tap installation and reading frequency. D. M. Allan. *Pipe Line News*, Feb 1961, **33**, 39.—The cathodic test tap provides a convenient means of obtaining regular electrical measurements in the field, which are essential to the main-

tenance of a cathodic protection system. The five types of test taps used by the Trans-Mountain Oil Pipe Line Co are: (1) single test tap; (2) four point test tap; (3) casing test tap; (4) pipe crossing test tap; and (5) insulating flange test tap. These tests are used to obtain measurements which give pipe-to-soil potential, pipe-to-pipe potential, and line currents. The test procedures are described in the paper with the aid of many tables and diagrams. M. F. M.

1052. Cathodic protection for old pipeline systems. O. E. Moore. *Pipe Line News*, March 1961, **33**, 18.—There are several factors involved in protection of an old line such as the anticipated length of service, its usage, working pressure, possibility of its salvage and use elsewhere, the present and projected cost of corrosion leaks and eventual pipe replacement, etc. There are generally three methods of protecting an uncoated line: (1) total protection; (2) reconditioning; and (3) hot spot protection. These methods are briefly described in the paper. Reference is made also to cathodic protection. M. F. M.

1053. Combating corrosion on Polish pipelines. (In Serbo-Croat.) L. Nawara and W. Popielski. *Nafta (Yugoslavia)*, 1960, **11**, 307–22.—The authors give a general survey of the existing types of corrosion and of electrochemical theories of corrosive processes. Several methods of protecting the pipeline against corrosion are described: anti-corrosive insulation through the protective coatings; application of inhibitors; cathodic protection; and protective preservation. Several methods of cathodic protection are described in detail. Execution of work for pipeline protection is explained. Phenomena of internal corrosion in pipelines are shown, as well as the means of resistance against them. (Authors' abstract.)

1054. Sulphide scaling under hydro-refining conditions. W. H. Sharp and E. W. Haycock. *Proc. Amer. Petrol. Inst.*, 1959, **39** (3), 74–91.—Corrosion rates in sulphide scaling of ferrous alloys have been obtained from continuous flow lab measurements under hydro-refining conditions. These conditions included hydrogen sulphide partial pressures of 0·3–150 psi in hydrogen at total pressures to 600 psi. Effects of temp were investigated over the range of 600°–1050° F for exposure periods of several hundred hr. Feed streams used consisted of hydrogen sulphide–hydrogen mixtures and additions of either desulphurized gas oil or platformate. Corrosion behaviour of organic sulphides without added hydrogen sulphide was studied. Analysis of the rate data has led to a graphical representation of corrosion rates that may be expected in long-term operation. (Authors' abstract.)

ENGINES AND AUTOMOTIVE EQUIPMENT

1055. Applied petroleum research on a vehicle dynamometer. J. Tubman and J. F. Manger. *J. Inst. Petrol.*, 1961, **47**, 107–13.—A vehicle dynamometer is described for testing vehicles having power outputs from 28 to 300 bhp and fully laden wt from 1700 to 4500 lb. It offers many advantages for fuel, lubricant, and engine testing over road testing, which include the completion of test programmes in less time, standardization of test conditions, the ease of adapting complicated and bulky instruments to the unit, and the ability to test at high speed.

The use of the dynamometer in assessing engine octane requirements, fuel anti-knock quality, and vapour lock tendencies are described. A. D. S.

SAFETY PRECAUTIONS

1056. Economics of a sound safety programme. 2. J. H. Herbert. *Oil Gas J.*, 13.2.61, **59** (7), 80–1.—In the second part of this series it is suggested that a 10–25% improvement in a company's safety record can be made in the first year if the board of directors reviews safety records at regular monthly board meetings. A. D. S.

1057. Refiners continue attack on air pollution. D. H. Stormont. *Oil Gas J.*, 20.2.61, **59** (8), 106–16.—A survey of air-pollution-control activities of 56 oil companies, accounting for 83% of U.S. refinery capacity, is presented. 35 of these companies reported expenditure on control measures, which this year will amount to $12·7 million. More than half of this amount is accounted for by expenditures for hydrocarbon control and combustion. Control of sulphur cpds requires the second largest outlay, with smoke and particulate matter and odour and fumes following in that order. Although air pollution control results in an overall net loss, there are benefits such as improved fuel-burner efficiency, reduced flaring, reduced corrosion, overall refinery efficiency, and better public relations.

Research on air pollution will total more than $1 million this year, half being for inter-company sponsored research and the other half for the oil companies. A. D. S.

1058. Fire protection in Kuwait. S. Harrison. *Petroleum, Lond.*, 1961, **24**, 147.—It is stated that the "front line" in fire fighting must be the actual operating staff, backed up by a more orthodox fire fighting force. The planning of fire protection is outlined in some detail. Protective arrangements are described under various headings—orthodox, general, and for special situations, such as for piers, hazardous locations, wells, etc. G. D. F.

1059. Sandblasting the top of a full crude tank is safe if blast crews prevent the build-up of static electricity. R. F. Gravitt. *Pipe Line Ind.*, 1960, **13** (3), 53–5.—It has been shown that neither the sparks struck by the sand nor the heat produced is sufficient to ignite the vapour from crude oil, but large static charges are produced. The operation is safe if the tank, operator, and all equipment are adequately earthed. G. B.

1060. Compressor test facility explosion. D. W. Schmitt. *Proc. Amer. Petrol. Inst.*, 1959, **39** (3), 34–41.—On 11 Feb 1959 a No. 2114 centrifugal compressor, of the type used as the high-pressure unit in oilfield repressuring service, exploded violently after approx 6 hr test operation at Ingersoll-Rand Co's Phillipsburg, N.J., plant. The test was being conducted by standard procedures, which included use of a closed loop for containing and recirculating the gas or air. The blast, which killed six men and injured numerous others, was centred in the low-pressure section of the test loop, which contained the flow nozzle. The coupling spacer between the compressor and speed increaser was shattered, either by misalignment or sudden overloading, and the resulting imbalance caused the pinion shaft to break. The cttee investigating the accident concluded that the initial ignition did not result from local overheating due to friction between moving parts and that, to prevent this type of explosion, test loops should be designed and operated to eliminate at least one of the three elements forming the combustion triangle (oxygen–fuel–heat). (Author's abstract.)

ECONOMICS AND MARKETING

1061. The changing energy pattern in Europe and its possible effect on product-mix. M. E. Hubbard. *J. Inst. Petrol.*, 1961, **47**, 75–82.—The Robinson Report is used as a basis for deducing the change in product-mix. The author has taken 1958 and 1968 as convenient years to be considered, and arrives at the following conclusions.

Although the gasoline proportion will continue to fall marginally, this will be more than compensated by sales of refinery gas to gasworks and by LPG. The total "gasolines and lighter" group should show a small increase in percentage (23·6–26·0%). Fuel oil or residuals will drop considerably to as low a percentage as has been known in the last ten years (47·4–40·1%). Middle dist will rise to a proportion considerably higher than in the past (29·0–33·9%). Kerosine will remain roughly constant, and the whole of the increase will be concentrated in gas/diesel oil, particularly of the heating grades.

A. D. S.

MISCELLANEOUS

1062. Planning the formation evaluation programme for development financing. H. Vance. *J. Petrol. Tech.*, Feb 1961, **13** (2), 115–17.—An oil and gas loan is secured by a mortgage on a producing property capable of giving future net income from the production of oil and gas, the income being used to pay off the loan, while leaving a residue for the borrower, who on this account will be interested in operating so as to protect his own equity. Oil loans generally carry a higher rate of interest than other loans, because it costs the average lending agency ½–1% to process and service an oil loan. The future rate of production and the yearly net income must be determined down to the economic limit. The bank will apply a safety factor, and therefore the engineer should not use a personal safety factor without disclosing it. The present value of future net income is obtained, and banks commonly apply a factor of two in fixing loans. Some require at least 18 months of production history, but this is no help to a man starting in the oil business. Sometimes volumetric data may be employed to assess reserves after comparison with behaviour in fields showing similar conditions. Production history, pressure, test and PVT data, logs, subsurface maps, field rules, operating costs, purchaser of production, and price constitute the basic data for evaluations. G. D. H.

1063. Engineering the oil loan. J. M. Sonosky. *J. Petrol. Tech.*, Jan 1961, **13** (1), 19–23.—The engineering forecast in connexion with a proposed loan must contain an estimate of future annual production, gross revenue, operating costs and taxes, net revenue or profit, and the present worth of the net revenue. Past production history, geological and reservoir data are needed for evaluation of the report. The fair market value of the property must be determined. Banks usually limit a loan to a max of 85% of this value. It may be based on an actual sale, recent sales of similar properties, a rate-of-return basis, going unit prices, value/brl of daily production, or on two-thirds of the present worth of the net revenue.

The loan, plus interest, must be repayable from a certain percentage of gross revenue within a specified period. The effect of operating costs is critical. A small operator will require a greater percentage of his gross revenue to operate than does a larger company. Banks usually have a five-year max for oil loans, and prefer a three-year range. Experience has shown that for a loan to be safe from a banking angle and not an excessive burden on the borrower, it is suggested that when the loan has been repaid the operator should have remaining net revenue of at least 50% of the future net revenue forecast at the time the loan was made. Another test is that the time to produce 50% of the reserves should exceed the expected loan term. A repayment schedule should be prepared.

An example of loan calculations is given. G. D. H.

1064. Operations research, a new discipline of interest to the petroleum engineer. F. H. Allen and K. R. Jones. *J. Petrol. Tech.*, Jan 1961, **13** (1), 11–15.—Operations research involves setting up a mathematical model of the situation under consideration. The various factors included in the mathematical statements of equality and inequality, and the answers, can be restricted within predetermined limits. High-speed digital computers can be used for the iterative calculations frequently required, and make it easy to analyse a series of cases by varying the basic assumptions. The aim is the best solution in terms of a mathematically determined optimum, max or minimum, of the objective function, which may be profit, distance, blending, layout, or timing, depending on the problem. Linear programming is an important technique in operations research.

Two examples are discussed for purposes of illustration, and an indication is given of the range of uses and of sources of information. G. D. H.

1065. Let Ana do it! J. D. Kent. *Pipe Line News*, Feb 1961, **33**, 26.—Waste hp due to pulsations in the piping can be as high as 25 or 30%, but this waste can be reduced considerably by the use of Analog (Ana for short!)—electrical analogy based on the similarity in behaviour of electrical and acoustical systems. The Analog described in this paper is not a computer in any sense and does not solve the problem; it merely simulates the acoustical properties of the piping system, and thus helps to eliminate trouble.

M. F. M.

1066. Engineer's view of federal income taxes. W. S. Eggleston. *J. Petrol. Tech.*, Feb 1961, **13** (2), 125–9.—Capital costs are recoverable only over a period of time fixed by the estimated life of the plant or equipment, or by the economic life of the mineral deposit. Expense costs are taken into account currently. For tax accounting purposes in the U.S.A. royalty oil is considered as a purchase. In Venezuela royalty is deductible as an expense in calculating income tax, and is considered as part of the total tax. The costs of lands proved productive, together with the costs of the associated geological and geophysical work, are capital charges. These costs are written off as oil or gas is produced at a cost depletion rate fixed by dividing the net book investment by the estimated reserves. When cost depletion exceeds percentage depletion, cost depletion is the basis for allowable depletion. The amount of percentage depletion depends on income. Cost depletion on typical properties may range from under 1c/brl to 30c/brl, and in the U.S.A. averaged 6c/brl some years ago; it may now average 10–15c/brl.

Most companies prefer to capitalize the total cost of drilling and development for book purposes, but elect to expense intangibles for tax purposes. This may give a higher total deduction for income tax purposes than does capitalization of these costs. Current expenses on the operation and maintenance of wells are expense items. Overheads are expense items, and the make-up varies with the company.

The independent action of federal, state, county, and city governments and tax assessors may in the U.S.A. result in the

division of profits after all normal costs so as to leave the operator with only 46%. G. D. H.

1067. Instrumentation. E. D. Reeves. *Internat. Oilman*, 1960, **14**, 313–14.—The need for rapid development of greatly improved instruments with computer process simulation and control through all stages of the industry is stressed. The fields most needing better instrumentation are exploration, reservoir engineering, refining, research, and marketing. G. B.

1068. India's drive for oil self-sufficiency. W. B. Metre. *Petroleum, Lond.*, 1961, **24**, 133.—India's plans for industrialization will be much retarded unless self-sufficiency in oil is achieved. Consumption of petroleum products since 1948 is tabulated, and predictions of future requirements are made. The consumption of the individual products and the state of the supply are then reviewed in more detail. Investment in the oil industry (in exploration, development, production, refining) is outlined. G. D. F.

1069. ENI operates world-wide. E. Mattei. *World Petrol.*, Feb 1961, **32** (2), 37.—The Italian state oil company, ENI, was set up in 1953 to develop prospects in the Po Valley, but since then operations have been extended to cover the rest of Italy and Sicily, and now in foreign areas. Main results have been the discovery of the Gela oilfield in Sicily in 1957 and the Ferrandina gas field in Lucania in 1959. An extensive natural gas pipeline system has also been constructed, refineries have been modernized and enlarged, and petrochemical plants have been built. Recent developments in ENI include exploratory activity through associated companies in Iran, Morocco, Somalia, Sudan, Libya, Tunisia, and Egypt. In some areas the search has proceeded to the drilling stage. Apart from foreign exploration, ENI is aiming to develop interests in transport, processing, and products distribution outside Italy. These will enable it to strengthen its independence in the oil market. C. A. F.

1070. Soviet oil threatens the Middle East. Anon. *World Petrol.*, Feb 1961, **32** (2), 41.—It is claimed that Russian oil poses a threat to international oil markets, particularly from the Middle East. In 1959 Middle East oil products totalled *ca* 232 million metric tons, and in the same year the U.S.S.R. produced *ca* 129 million metric tons, five times more than the production of 1945. There are plans for boosting Russian production to 230–240 million metric tons by 1965 and to 350–400 million tons by 1972. There are said to be large untapped reserves in the Central Asian republics of Turkmenistan and Uzbekistan, amounting to more than the entire Middle East reserves. In a few years it is likely that the Middle East will be competing fiercely with the U.S.S.R. in world oil markets. C. A. F.

1071. Applied hydrocarbon thermodynamics. Pt 21. Nomographs and convergence pressure correlations of vapour liquid K-values. W. C. Edmister. *Petrol. Refin.*, 1960, **39**, 293–302.—The empirical correlations of vapour liq K-values by nomographic and convergence pressure methods have been examined in detail. Charts are given of the Winn nomographs, evaluated from systems, the standard deviation being 9·4%. The Brown K ratio method, based on the use of an intermediate parameter K_{10}, was also included. Charts are also given of the NGGA nomographs and the Hinshaw charts specifically correlated for aliphatic hydrocarbons. M. J. M.

BOOK REVIEW

Recent Sediments, Northwest Gulf of Mexico. Ed. F. P. Shepard, F. B. Phleger, and Tj. H. van Andel. Tulsa: American Association of Petroleum Geologists, 1960. Pp. 394.

Wernerian dogma at last surrendered to Hutton's and Lyell's actualistic conception of earth history. This change in the fundamental basis of the science created amongst early nineteenth century geologists a discipline based on the mapping and systematization of the layered crust, exercised to the present day, both in communities scientifically advanced and in those where geological work has only recently begun. But the massive accumulation of facts, while leading to an accurate knowledge of the broad patterns of deposition and orogeny, has led generally to the loss from sight of actualism's full powers. So far as *understanding* the depositional record, this is particularly true.

If indeed the stratigrapher makes interpretations, it is done intuitively rather than by any critical appeal to hard facts about modern sediments and observable depositional processes. Even now the necessity for such appeals is not seriously granted by the mass of stratigraphers and some claiming to be sedimentologists. And, sad to say, this is hardly least in academic and official circles, still transfixed by "formation" and "zoning" and related obsessions.

Consequently, the intensive study of modern sediments and use of the results in interpretative work has long been delayed, but happily the last 30 years have seen an ever-growing interest in this field. Near-shore and shallow marine sediments are now fairly well known. Present-day continental deposits, however, have yet to be studied in any serious way, despite their obvious past importance. Moreover, the difficulties arising from differences in approach, which separate workers on modern sediments from students of past sedimentary products, are now slowly being removed as individuals begin to practise in both fields.

So far, most attention to modern deposits has been paid in North America, but important results have also come from the Netherlands and Germany. In the U.K., too, interest is mounting, and modern sediment work has begun at several institutions. Reading University will shortly open a comprehensively equipped sedimentology research laboratory, with facilities for many senior workers.

The oil industry has contributed substantially to this field, by financing research in the universities and by work in its own laboratories. Still greater efforts are within its power, but "Recent Sediments, Northwest Gulf of Mexico" is a fitting tribute to the vision and interest already shown, as well as being a major contribution to knowledge of present-day sedimentation. The symposium synthesizes work carried on in API Project 51, which had as its objective "the study of near-shore recent sediments and their environments in the Northern Gulf of Mexico." The project was given to the Scripps Institution of Oceanography (University of California), and was for long directed by F. P. Shepard.

The 13 original papers in the volume are concerned chiefly with the character and distribution of sediments and faunas in the Mississippi Delta, the Texas bays, and the Texas–Louisiana continental shelf. They vary in scope from discussions of phytoplankton production to the build-up of Holocene deltaic and barrier sands, *i.e.* potentially, from proto-oil to possible ultimate reservoirs. The papers are uniformly well-written, with clear and plentiful illustrations. There is an excellent consolidated bibliography of more than 500 titles. Many of the results are, of course, already published, but generally in scattered and unrelated papers.

G. E. Murray's contribution on the geological framework

of the Gulf Coastal Province shows that Pleistocene–Holocene sediments represent only a brief episode in the long-continued filling of this geosyncline inward from its rim. Already a maximum thickness of 50,000 feet of Mesozoic–Quaternary beds has accumulated. Allowing for the relative rapidity of the Holocene transgression compared with much earlier ones, it is clear that the present spatial distribution of sediment types broadly resembles that of past times.

Problems of the provenance and dispersal of Holocene sediments are examined by Tj. H. van Andel, who discusses the independent distribution of sand and clay fractions on the Gulf shelf, from the main influxes of the Rio Grande–Colorado and Mississippi Rivers. Unhappily for classical theorists, mineral suites spread over the shelf but poorly reflect the tectonic aspect of the source, which varied from cratonic to orogenic.

The Holocene transgression is undoubtedly the backdrop for modern sedimentation on the margin of the Gulf geosyncline. This, the most recent of Quaternary eustatic movements, raised sea level to its present height from a lowstand of some 50 fathoms. The progress of the transgression, and the physiographic and depositional products of the episode, is traced by J. R. Curray against a time-frame based on radiocarbon dates from dredged shells. Also, Shepard summarizes with additional data the Holocene rise of the Gulf, and shows the general agreement of the pattern with that from far-distant parts of the world. The Mississippi Delta area, however, subsided more rapidly and independently of the more stable Texas shelf.

The modern Mississippi birdfoot delta is seventh in a sequence of imbricating Holocene deltas built out from the alluvial valley of the river against the fluctuating Gulf waters. Imbricating deltas occur also, for instance, in the Rhône Delta. P. C. Scruton discusses the role of constructional and destructional episodes in delta-building, a cyclic pattern which in the past has undoubtedly led to at least one kind of cyclothem. In the constructional phase, topset, foreset, and bottomset delta sediments build out into the sea until the distributary rivers reach a critical length. When this occurs, crevassing near the " head of passes " generally succeeds in diverting the entire river to some new site, when a new delta is built up. The destructional phase then begins in the abandoned delta as it subsides beneath the waters, and the topset alluvial sands are reworked and transgressed by the sea.

Over this veneer a new delta pile may ultimately be spread. The distribution of sediments in relation to hydrography and bottom topography in the present Mississippi Delta is discussed by Shepard. Criteria for the identification of ancient delta environments are advanced. Important to petroleum geologists is Shepard's reminder that sand bodies in deltas may extend in *two* possible directions: parallel to the delta margins (beaches, barrier islands), and along the distributary channels (levees, point bars). Such shoestring sands are potential oil reservoirs.

West of the muds rapidly accumulating around the Mississippi Delta, the chief Holocene deposits are sands, apparently laid down as transgressive systems of beaches with perhaps spits and islands backed by shallow lagoons or bays. The modern coast, spanning several climatic belts, is also formed largely of sand barriers sheltering muddy bays and lagoons from the open Gulf. The deposits of these complexes have in some areas accumulated to substantial thicknesses. Sedimentation in them is comprehensively treated by Shepard, D. G. Moore, and G. A. Rusnak, who present much new information on lithology and depositional structures. Furthermore, Shepard demonstrates that similar barriers are of worldwide occurrence and related to submergent and steady coasts, rather than to emergent shores. If fossilized, as their location within a generally transgressive series makes probable, these barrier sands might prove important as oil reservoirs, since they occur as pod-like swellings in otherwise thin sand-sheets.

On the biological side, F. B. Phleger and R. H. Parker give well-documented studies of the distribution of micro- and macro-invertebrates in relation to environmental conditions on the Gulf Coast and shelf and in the Missiasippi Delta. Significantly, the faunas often prove better than lithologies in the distinction of sedimentary environments. These two papers fully justify the multiple approach used in Project 51 and are invaluable for their plates alone, which group the various organic assemblages.

The work carried on under Project 51 has been modestly described by its executants as " reconnaissance," but to the outsider " Recent Sediments, Northwest Gulf of Mexico " embodies a comprehensive and detailed factual treatment of the sedimentary products of a transgressive episode at the edge of a modern geosyncline. The richest fruits of the work will undoubtedly spring from applying the data to the Mesozoic–Tertiary beds of the Gulf Province itself, but the general results should certainly aid, and indeed already have aided, workers farther afield in solving their sedimentological problems. As knowledge of modern sediments grows—and API Project 51 has made perhaps the most significant contribution to date—it becomes more and more incumbent on stratigraphers and sedimentologists to work out their uniformitarian inheritance, whether in teaching or industrial practice. Geology can be nothing if not contemporary. J. R. L. A.

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OILFIELD EXPLORATION AND EXPLOITATION

GEOLOGY

1072. Facies studies can reconstruct oil-forming environments. O. L. Bandy. *World Oil*, April 1961, **152** (5), 68.—Extensive studies of marine geology and faunal assemblages on the sea floor are being carried out over many areas, and it is possible to determine depositional environments favourable for oil accumulation. Palæo-environments can also be reconstructed by facies studies using foraminifera. These are abundant in marine sedimentary rocks and environmental logging has recently been attempted in order to determine the framework of the depositional basin. Faults can also be detected by environmental analyses, together with conditions favourable for deposition of possible reservoir rocks. Examples are given of interpretation from the Central Valley of Luzon in the Philippines. One indicates the problem of deeper water clastics, and it is shown that a sand body normally interpreted as a shelf deposit is associated with beds containing deep water foraminifera. It is likely that the sand was brought in by turbidity currents and is not necessarily a shallow water deposit. Three refs. C. A. F.

1073. Photogeologic leads can be deceptive. Anon. *World Oil*, April 1961, **152** (5), 73.—Photogeology provides a relatively cheap method of reconnaissance exploration, and in the U.S.A. there are now few areas which have not been mapped photogeologically at least once. Competition now requires thorough analysis and interpretation, and it is recommended that drainage anomalies in particular should be checked against other photogeological data. Examples are given of four areas where detailed stereoscopic analysis has enabled unconsolidated flat-lying beds to be mapped. Drainage patterns of these are analysed, and fault evidence is indicated with low dips. Geophysical surveys are recommended over the interpreted fault zone. Locally anomalous erosional histories can aid the solving of the tectonic history of an area and may provide data leading to the finding of stratigraphic traps. But the method is time-consuming and requires much attention to detail. C. A. F.

1074. How to analyse strand lines from heavy minerals, facies data. E. W. Biederman. *World Oil*, April 1961, **152** (5), 76.—The shoreline complex of sands off the New Jersey coast

has been studied following a comparison with the shoestring pay sands of Kansas. It has been found that the concn of heavy mineral sands in the recent deposits occurs at a strategic location which can assist in the interpretation of ancient equivalents. The lagoonal shoreline of the barrier island shows relatively high concn of ilmenite and other heavy minerals. Such a concn has been found in several locations in the same environment. The vertical sequence of these recent deposits as shown by cores is discussed: it consists of, from bottom to top, carbonaceous shale, a thin sand, dark grey marine shale, sandy shale, well-sorted sand with heavy minerals, cross-bedded sand, coarser sand with shell fragments. Such a sequence may be expected in ancient rocks. Six refs.
C. A. F.

1075. Exploration showing is worst in 12 years. Anon. *Oil Gas J.*, 20.3.61, **59** (12), 66–8.—The overall success ratio in the 11,704 wells drilled in the U.S.A. in 1960 was 18·7% compared with 19·8% in 1959. Statistics collected over the past six years show that only one new-field wildcat in 60 drilled in 1954 has been profitable. At the time the success ratio was reported as 1 in 8. The 1960 success ratio was 30·4% in W Canada and 12·7% in E Canada. Mexico had a success ratio of 43% in 1960. J. C. M. T.

1076. Geologists study Frankston success in East Texas. F. L. Oliver. *Oil Gas J.*, 27.3.61, **59** (13), 152.—The Frankston reef trend in E Texas has proved to be a significant producing zone since the first discovery in 1955, and similar trends elsewhere in the basin are being sought. Production comes from the James formation, which has hitherto been generally found tight, consisting of a brownish grey, dense limestone. Locally a reef is developed which trends NW–SE approx perpendicular to the structural grain of the area; it is made up of a fossiliferous, oolitic, coquinoidal reef with some dense crystalline and sandy porous zones. Permeability and porosity are good, and there is some vertical fracturing. A map shows the structure of the Frankston area, and faulting is indicated. An electric log cross-section indicates the reef build-up with porosity wedging out to the N and S of the developed area. Depth to the top of the James is *ca* 10,000 ft and approx 60–80 ft is porous out of 100–150 ft of reef. Crude averages 49° API, porosity 13·6%, and permeability less than 50 mD. Connate water saturation ranges from 28 to 50%. Over 100 million brl in place are estimated.
C. A. F.

1077. Oil comes to old East Texas gas field. Anon. *Oil Gas J.*, 10.4.61, **59** (15), 154.—Oil has been found in an old gas producing area near Bethany, E Texas. Gas has been produced in the area since 1920, and several oil pays have been found in recent years. Pays are less than 4000 ft in depth, and drilling is economical. Cumulative oil production to Jan 1961 was *ca* 2 million brl. C. A. F.

1078. West Texas gas field may cover 50 sections. R. J. Enright. *Oil Gas J.*, 20.2.61, **59** (8), 80–2.—The thick Ellenburger pay of the Brown-Bassett field, W Texas, has been proved for at least 16 miles along the Pandale anticline. The discovery well drilled in 1953 tested 4,300,000 cu ft/day. With 12 wells drilled, reserves were recently estimated at 800 billion cu ft—but *ca* half this is carbon dioxide. Carbon dioxide is absent from the small quantities of gas found in overlying Strawn limestone and Connell sands, although the anticline is extremely faulted. J. C. M. T.

1079. Red Cave—Cinderella of Texas–Oklahoma Panhandle. C. Stevens. *World Oil*, April 1961, **152** (5), 104.—There is active development of shallow gas production in the Texas and Oklahoma Panhandles. The Permian Red Cave formation, formerly overlooked as a potential reservoir, has provided *ca* 70 producers in *ca* one year with pay at depths of 1400–2700 ft. Gas at up to 19 MMcf/day is being produced, and productive area so far covers 225,000 acres semi-proven. Most of the production comes from the old field area of Potter, Carson, Hutchinson, and Moore Counties, and the area is unique in being the first major reservoir to be found with gathering and trunk facilities, and markets already established. Before 1959 the pay was little known, and it is remarkable that such a major reservoir could have been bypassed during some 40 years of intensive drilling in the Panhandle area, where *ca* 15,000 oil and 5000 gas wells have been drilled since 1958. C. A. F.

1080. Early Pennsylvanian sedimentation in Southeastern Kentucky and Northern Tennessee. R. E. Bergenback and R. L. Wilson. *Bull. Amer. Ass. Petrol. Geol.*, 1961, **45**, 501–14.—The purpose of this study is to discuss the relation in a part of the Cumberland Plateau in N Tennessee and SE Kentucky of early Pennsylvanian stratigraphy and sedimentation to the underlying Upper Mississippian erosion surface, and to point out the application of this relation to coal-reserve studies and oil and gas exploration.

In this area, structural disturbance is at a minimum, except for broad uplift and warping. Minor slumping was observed near the base of the Pennsylvanian. E. N. T.

1081. Geologists differ on Arkoma's future. J. C. McCaslin. *Oil Gas J.*, 20.3.61, **59** (12), 177.—Oil and gas prospects of the Arkoma Basin of Arkansas and Oklahoma are problematical, and gas reserves have been estimated at up to 1½ trillion cu ft and 450 Mcf/acre-ft. Although exploration has been carried out intermittently since 1902, there have been few finds, although two gas fields found before 1911 are still producing. Substantial gas production was found in the Red Oak and Spiro sands in Latimer County in 1960, testing sands deeper than those hitherto found productive in the basin. Greater drilling density is anticipated, and the need for deeper drilling is emphasized. Sands are abundant, but there are drilling problems, such as low penetration rates and Atoka shale caving. C. A. F.

1082. Arkoma Basin moves quickly into contention for gas-finding. J. C. McCaslin. *Oil Gas J.*, 24.4.61, **59** (17), 206.—Natural gas was formerly a by-product of exploration, but in recent years there has been increasing interest in the search for gas. New gas basins have been found and are being developed in the U.S.A., such as the Arkoma Basin of Arkansas and Oklahoma. In this basin there is active wildcatting, and in the past 15 months eight gas fields have been found in the Oklahoma zone and eight in the Arkansas side of the basin. The most active areas are Red Oak–Norris, Old Redland, NW Kenta, and Potato Hills. Many stratigraphic problems have arisen whilst drilling, and it seems that trapping is stratigraphic. C. A. F.

1083. Watchful waiting in Ouachitas may end—pending outcome of key test. P. B. Bike. *Oil Gas J.*, 3.4.61, **59** (14), 266.—A well is being drilled on the Moyers anticline in Pushmataha County, Oklahoma, to seek for Mississippian Stanley sand. The anticline is 25 miles long and is one of many anticlines in the region which is within the Ouachita Mountain province. Until recently this had not been considered a good prospect for commercial oil. The Moyers anticline is a prominent surface feature with dips of *ca* 55°. At depth dips are thought to fall to *ca* 25°, with closure at 5000 ft of *ca* 1500 ft. Subsurface geology in the area is complex, but wells in the area have had many gas shows, and it is hoped that favourable sand conditions will yield commercial oil.
C. A. F.

1084. Cambrian rocks may hold big reserves. J. C. McCaslin. *Oil Gas J.*, 24.4.61, **59** (17), 208.—Cambrian rocks produce less and have been less explored than any other geological system,

although they have a wide distribution. Six states in the U.S.A. and one in Canada produce Cambrian oil, and the oldest is Gorham field on the Central Kansas Uplift, discovered in 1926. The most recent find is at Silver Creek on the Cambridge Arch of Nebraska. Cambrian production in Ontario, Wyoming, Texas, Ohio, and Kansas is outlined, and tables and charts show the Cambrian producing areas of N America. Most Cambrian fields are in Kansas, where 21 are listed, and there are nine in Texas. Potential areas of future Cambrian production are noted. C. A. F.

1085. Megagroups in Illinois. D. H. Swann and H. B. Willman. *Bull. Amer. Ass. Petrol. Geol.*, 1961, **45**, 471–83.—A megagroup is a rock-stratigraphic unit ranking above group. Seven megagroups are herein recognized in the pre-Pennsylvanian and one in the Mesozoic and Cenozoic rocks of the Illinois region.

A megagroup is defined and recognized primarily because of the kinds of rock it contains rather than for its time of origin, fossil content, relation to unconformities or to cycles of deposition, or other features. More latitude must be allowed in interpreting the lithologic unity of a megagroup than that of a formation or a bed. Units of contrasting rock may properly be contained within a megagroup provided they are neither so numerous nor so large as to destroy its overall lithologic unity. E. N. T.

1086. Stratigraphy of Upper Silurian Cayugan evaporites. H. L. Alling and L. I. Briggs. *Bull. Amer. Ass. Petrol. Geol.*, 1961, **45**, 515–47.—At the present time it is possible to define the stratigraphy of evaporite basins of the Cayugan series, and to trace the stratigraphic units from basin to basin. With less precision it is also possible to correlate the stratigraphic units of the basin centres with the classical units of the basin margins through the numerous samples of drill cuttings, drill cores, and the many hundreds of drillers' logs and electric logs now available.

The sedimentary framework for Cayugan rocks involves the development and growth of Niagaran reef platforms around the Michigan and Ohio Basins which prevented free interchange of oceanic brine between the open sea and the basin, and which formed the ultimate control on subsequent evaporite deposition. E. N. T.

1087. Recipe for success in Railroad Valley. F. J. Gardner. *Oil Gas J.*, 17.4.61, **59** (16), 155.—A 5000-ft wildcat is to be drilled to the Mississippian in White Pine County, Nevada, in an area where there is little control, apart from surface geological surveys. Only one oilfield has been found in the state, at Eagle Springs, and this has yielded only a little heavy oil from Tertiary tuffs below 6500 ft. The new test is *ca* 40 miles N of Eagle Springs. C. A. F.

1088. Montoya dolomite and Fusselman dolomite in Silver City region, New Mexico. W. P. Pratt and W. R. Jones. *Bull. Amer. Ass. Petrol. Geol.*, 1961, **45**, 484–500.—The subdivision and nomenclature of the Montoya and Fusselman have had an involved history since the two formations were originally differentiated and named. The major developments in this history are reviewed and are summarized diagrammatically, in order to provide a background for the discussion of the Montoya and Fusselman at Silver City.

Excellent to fair exposures of the Montoya and Fusselman dolomites occur at three places in the Silver City region: at Lone Mountain 6 miles to the SE; at Bear Mountain 6 miles to the NW; and near Georgetown 16 miles to the NE. At all three places both the Fusselman–Montoya contact and the four units of the Montoya can be recognized and traced in the field. E. N. T.

1089. New sediments may help Pan Am find ancient oil-bearing sands. M. Blakely. *Oil Gas J.*, 20.3.61, **59** (12), 81–2.—Pan American Petroleum Corpn are making a study of Recent sediments in the Gulf of Mexico in an effort to find criteria for locating stratigraphic oil traps. Coring to a uniform depth of 2½ ft into the bottom sediment in water depth of 10–480 ft was carried out from trawlers, and similar samples have been taken up a number of rivers. All samples are studied from the point of view of grain size, texture, mineral composition, isotopic composition of organic carbon, micropalæontology, and palynology. It is hoped that the study will enable the exploration geologists to determine the trends of old shorelines and the distribution of inlets and deltas, and to discriminate between dune, river, and beach sand. J. C. M. T.

1090. Lithofacies maps may help pinpoint oil areas. P. B. Bike. *Oil Gas J.*, 6.3.61, **59** (10), 184.—The Idaho Government has proposed a $50,000 bonus to the first significant oil discovery in the state. Only 67 wells have been drilled since 1903, and in the most favourable area in the SE only 23 tests have been drilled over an area of 28,000 sq miles. The use o lithofacies maps in evaluating this area is discussed, and these show that there are two likely provinces: the Snake River downwarp and the Great Basin. Little is known of the structure and stratigraphy in these areas. Details of stratigraphy based on a series of lithofacies maps are described, and there appear to be potentially favourable structural conditions in the Cambrian and other rocks. Favourable conditions for stratigraphic trapping in carbonates and sandstones should occur in various areas. Formations range from Cambrian through Cretaceous. C. A. F.

1091. Drilling of dry hole stirs Oregonians interest. Anon. *Oil Gas J.*, 20.3.61, **59** (12), 178.—93 dry holes have been drilled in Oregon state since 1902. 1 Leavitt, the latest well, was abandoned in basalt at 9579 ft. Several recent unsuccessful wildcats have been drilled in Lake County in spite of promising indications from surface geological and geophysical surveys. C. A. F.

1092. Offshore Oregon attracts lease offer. R. J. Deacon. *Oil Gas J.*, 17.4.61, **59** (16), 156.—The offshore extensions of the onshore basins of Oregon have long been thought more attractive for exploration, and recently a blanket lease has been applied for over the entire offshore area. Geological prospects of the region are outlined, but there are little drilling data from the coastal belt, which has been largely neglected. The Oregon coast range forms a major high flanking structural basin; to the W are, from N to S, the Nehalem embayment, and the Newport and Coos Bay embayments. These are represented only by a narrow onshore belt. In Coos Bay there are Upper Eocene to Pliocene marine and non-marine beds aggregating over 9400 ft; numerous gas shows have been found in shallow wells, and there are a few anticlines and areas with fault closures. Marine sediments reaching over 10,000 ft are known in the Newport embayment, and these probably thicken offshore. Beds range from Upper Eocene to Middle Miocene, and a little oil has been found. In the Nehalem embayment there are *ca* 8500 ft of sediments, mainly marine, ranging from Upper Eocene to Middle Miocene. One well in the area had reported oil and gas shows, and offshore structures are likely. C. A. F.

1093. Resistivity mapping and petrophysical study of Upper Devonian inter-reef calcareous shales of Central Alberta, Canada. R. G. McCrossan. *Bull. Amer. Ass. Petrol. Geol.*, 1961, **45**, 441–70.—The Upper Devonian Woodbend reefs of Alberta are surrounded by very fine-grained argillaceous limestones and calcareous shale, and the main purpose of this study is to investigate the distribution of the carbonate content of these shaly deposits to determine its relation to the reefs.

The relation between carbonate content and resistivity is very useful even if it is not linear. If the carbonate contentis high, a small increment effects a larger increase in resistivity than at a low carbonate content. Thus resistivity increases disproportionately and differences are emphasized. Equally important in actual mapping is the thickness of the calcareous beds. In general, high resistivity in shale at depths of less than *ca* 10,000 ft indicates a high proportion of carbonate or quartz impurities. Compaction is likely to change resistivity appreciably only if a bed, fairly high in carbonate, has very low porosity. E. N. T.

1094. Arrowhead River strike expands Canadian gas arena. F. J. Gardner. *Oil Gas J.*, 3.4.61, **59** (14), 265.—A new find in Devonian Slave Point is reported from the NW Territories of Canada. The pay has become an important reservoir in NE British Columbia and W Alberta since first production was found in Virginia Hills, Alberta, in 1957. The new well, 5–7 Netla, in the Arrowhead River region, on test flowed gas at 6800 Mcf/day from a 48-ft interval at *ca* 6400 ft. The find emphasizes the great future potential of the N lands of Canada, but development will depend on outlets for these fields, which are at present remote. C. A. F.

1095. American firm uses aerial survey to map Jordan. Anon. *Oil Gas J.*, 27.3.61, **59** (13), 160.—An aerial photographic survey is to be carried out over *ca* 30,000 sq miles of Jordan in order to aid new mineral and oil studies, and for general planning. The area is in E Jordan, which has not yet been mapped, and consists mainly of rugged desert, which will present major problems for ground measurements which will accompany the survey. First maps are expected to be delivered in 1963 on a scale of 1 : 50,000 with 20-m contours. A ground survey of the same area would take over 20 years, compared to the three required for the aerial work. C. A. F.

1096. Commercial gas is found in Queensland, Australia. D. M. Traves and H. M. Thralls. *World Oil*, April 1961, **152** (5), 101.—The oil and gas possibilities of the Roma area, Queensland, have recently been re-evaluated, and further tests carried out. One of these, Pickanjinnie 1, on test flowed 6½ million cu ft/day, and two others also had gas production. Gas was first found at Roma in the early 1900s, and sporadic exploration and drilling have been carried out over the past 50 years with encouraging but non-commercial results. The later discoveries, in an area formerly thought to have been amply tested, had the best flow of petroliferous gas yet found in Australia. The geology of the area is reviewed: formations range from Lower Cretaceous through Permian, and gas sands have been found in Permian sandstones, which are slightly metamorphosed in places. Recent seismic surveys have been made which provided sites for the recent finds. It is claimed that many of the old wells were unsuccessful as they were sited on surface geology which cannot be used successfully to interpret subsurface structure which involves major unconformities and complex fracture systems. Further seismic surveys and drilling are to be carried out in the area. C. A. F.

1097. Commercial oil still eludes Aussies. J. Flower. *Oil Gas International*, March 1961, **1** (3), 22.—In spite of a costly search for oil in Australia, there has so far been no commercial success. Up to the end of 1960 *ca* 500 wells had been drilled at a total cost of *ca* £A63 million. Surface indications are known, and very small amounts of oil have been obtained from wells. Best prospects are probably in W Australia, where a little oil was found in 1953. Largest area of sedimentary basin is in Queensland, and most exploration has been concentrated around Roma. The most encouraging recent find was on the S coast of Victoria, where natural gas was discovered in 1959. Oil search in Australia is aided by government subsidies and taxation concessions. The history of exploration in Australia and New Guinea is outlined, and it is emphasized that considerable geological and geophysical work remains to be done before the oil prospects of Australia can be defined. C. A. F.

GEOPHYSICS AND GEOCHEMICAL PROSPECTING

1098. Radiation surveys *can* find out. G. H. Miller. *Oil Gas J.*, 13.2.61, **59** (7), 124–7.—It is reported that a geochemical and radiation survey carried out over the same area gave very similar patterns, but the latter took only ⅛ the time and cost ⅓ of the former. In the " halo " above a petroleum accumulation there is an excess of gas escape, and consequently of water evaporation, more water moving in to take its place. This leads to a concn of dissolved minerals, including traces of uranium salts, giving rise to the radiation halo. Maps are made using a 10,000-cu inch ionization chamber, which has a high sensitivity and low rate of drift. Radiation surveys of Little Creek field and McComb area, Mississippi, made before oil discovery, closely delineate the subsequent productive area. Radiation surveys should be interpreted in conjunction with other geophysical and geological data. J. C. M. T.

1099. How to analyse reflection data in permafrost areas. R. A. Boulware. *World Oil*, April 1961, **152** (5), 80.—Success of seismic reflection techniques in overcoming permafrost problems has encouraged the study of problems of many aspects of oilfield development in Arctic regions. Permafrost can be divided into three types: continuous, discontinuous, and sporadic, and thicknesses can be highly variable. Temp gradients in the layer vary vertically and horizontally, and seismic velocities similarly vary considerably. Velocities depend on whether the zone is continually below freezing and whether it is entirely dry, and other factors, such as presence of ice lenses and nature of material before freezing. Reflected energy can be obtained at times from the base of the permafrost, and the depth of the interface can be determined. Deeper reflected events from below the permafrost can be corrected for any variations caused by the zone. Examples of seismic records from permafrost zones are included. 12 refs. C. A. F.

1100. Team work speeds Alaska oil hunt. P. B. Bike. *Oil Gas J.*, 1.5.61, **59** (18), 170.—The operation of the Precon service, which provides integrated gravity and seismic services in Alaska, is described. Gravity work is specially adapted to helicopter lift, and trucks or David buggies are used in seismic work, except in snow, when Sno-travellers or Bombardiers are used. An airborne seismic drill forms a compact unit which can drill to 70 ft with short drill pipe lengths. Location finding is by a combination of aerial and USGS topographical maps; an exact fix is obtained by using the topographic camera after readings have been taken. C. A. F.

DRILLING

1101. Deep drilling increased 6% in 1960. E. Adams. *Petrol. Engr*, March 1961, **33** (3), B19.—In 1960, 242 deep wells were drilled in the U.S.A. at a cost of $165 million. A survey of deep wells drilled since 1938 is given, together with other deep well data of interest, *e.g.* costs, drilling times. Several new deep fields are mentioned. There is a list of deep well drilling contractors. Possible future developments are reviewed. G. D. F.

1102. Gulf hits 10,000 ft in 3·4 days to set drilling record in South Louisiana. V. D. Stone. *Oil Gas J.*, 27.3.61, **59** (13), 82–9.—A number of wells in Timbalier Bay, Louisiana, have

recently been drilled in less than five days and one in 3·34 days as the result of a plan to eliminate all work not absolutely necessary and reduce the time required to do the remainder. As a result, overall well costs have dropped 50% below the 1959 level. Blow-out preventers are bolted to a flanged body welded to the conductor pipe, and do not need to be removed to run subsequent casing strings. The conductor pipe is driven by pile-driver before the rig's arrival. Bits with ¾-inch jets are used with pump pressures of 2500–3100 psi to give jet velocity over 600 ft/sec and annular velocity over 200 ft/min. Rotary speeds of 180–450 rev/min and bit wt of 50,000–1,000,000 lb are used. In most cases drilling fluid is sea water, which picks up enough formation solids to reach 10 lb/gal by return to surface. Connexion time was cut from 4½ to 1½ min by mechanical improvements and changes of crew habits. A number of electric logs and tests were eliminated. In addition to cost savings through time reduction, fewer bits and less casing were consumed. No casing strings became stuck, and there was a decrease in fishing jobs.
J. C. M. T.

1103. How to prevent differential-pressure sticking of drill pipe. E. L. Haden and G. R. Welch. *Oil Gas J.*, 3.4.61, **59** (14), 214–19.—Lab tests show that the severity and frequency of pipe-sticking because of pressure differential can be decreased by the use of surface active agents, by using some mud types rather than others, and by decreasing the drill collar–filter cake area. Apparatus simulated a drill collar in contact with a permeable formation. The force needed to keep the drill collar moving or, if stuck, to break it away was measured as mud pressure and properties were varied. In muds weighted with barite the breakaway force increases with mud wt. The rate of increase is high with high-calcium muds and low with gypsum muds, but this effect is diminished if lubricants are added.
J. C. M. T.

1104. Drilling-cost charts—field level approach to cheaper wells. V. Edelberg. *Oil Gas J.*, 17.4.61, **59** (16), 102–5.—Drilling cost charts can help drillers to decide how long to run a bit and what wts and rotary speed to employ. They are based solely on local conditions. Charts are plotted for cost/ft and footage against drilling time. Bits are pulled when cost/ft reaches a minimum. Pulled bits are described as accurately as possible to help improve the programme on future wells. Examples of the method are given.
J. C. M. T.

1105. Ocean drilling passes first test. Anon. *Oil Gas J.*, 10.4.61, **59** (15), 72–3.—The pilot drilling for the Mohole project near Guadalupe Island in 11,700 ft of water demonstrates that wildcat drilling is now possible beyond the Continental Shelf. The first Guadalupe hoe was drilled in 70 hr. 25-mph winds and 12-ft waves were suffered. Two wire-line cores were taken, one at 110 ft and one at 234 ft. 4½-inch steel drill pipe is being used. The holes are uncased. The drilling fluid is salt water.
J. C. M. T.

1106. Mohole may give oilmen new drilling methods. Anon. *Oil Gas J.*, 27.3.61, **59** (13), 72–4.—The drilling plan for the Guadalupe test well drilled in 13,500 ft water depth includes several new ideas which may be of value to future marine oil drilling. No conductor pipe is used between the floating drilling vessel and the sea bed, but deflection in the drill pipe of up to 14° at the surface and 8° at the bed caused by roll and drift of the vessel are allowed for by funnel-shaped guide shoes. Casing will be set to 100 ft below the landing base on the sea floor. One diamond core bit only will be used to the projected depth of *ca* 1000 ft. Wire line coring equipment includes a 2-inch dia × 10-ft long punch corer for soft formations, and core brl for harder formations which will take cores $2\frac{7}{16}$-inch dia and up to 20 ft long. Three wt of 4½-inch drill pipe will be used: 20 lb/ft for the top 1500 ft, 16·6 lb/ft for the middle 3500 ft, and 13·75 lb/ft for the lower 8000 ft. The lowest 500 ft consists of 7½-inch drill collars and four bumper subs with a total stroke of 20 ft to accommodate heave. Danger through whipping of the exposed drill pipe is not expected, provided the rotary speed does not exceed 40 rev/min.
J. C. M. T.

1107. $20,000,000 saving in '61. E. McGhee. *Oil Gas J.*, 13.3.61, **59** (11), 176–9.—Advances made in the past five years in drilling straight holes through crooked-hole formations may save $20 million in the U.S.A. in 1961. Probably a further similar amount could be saved if limits on hole deviation were revised and if drilling contractors were able to pick the best site for bottoming in the desired area. Provided dog-legs are not severe, the actual angle of deviation is not important, and greater changes in deviation can be permitted near the bottom than the top of a well. A suggested example of permissible deviation is up to 1¼° in the first 1000 ft above bottom, 1° in the next 1000 ft, ¾° in the next 1000 ft, and ½° in the remaining distance to the surface.
J. C. M. T.

1108. Quick identification of formation brines. G. Mihram and K. A. Catto, Jr. *Oil Gas J.*, 6.3.61, **59** (10), 126–9.—The source of produced water can be found quickly and easily using flame spectro-photometry in place of chemical analysis. 30-ml samples of produced water are used in a flame photometer and the spectra recorded over the wavelength range of 325–900 mμ. The spectra are compared with those of known formation waters. The position and general shapes of the peaks are used for recognition. It is not necessary to know anything about the elements in the samples responsible for the peaks, and the mutual interference of certain combinations and quantities of elements is often actually of help in correlation. Correlations can be made in under an hour. Mixtures of brines with fresh water are easily identified. The operating procedure is given.
J. C. M. T.

1109. How to drill a slant hole. C. Lawrence. *Oil Gas J.*, 6.3.61, **59** (10), 109–11.—In W Los Angeles directional drilling is common, and experience there is described. Electric rigs are used. Depth of the first whipstock point varies between 500 and 6000 ft, and an average angle of 3°/100 ft depth is used to give total deviations of up to, typically, 20°. Single-shot surveys are taken every 30–60 ft during deviation build-up, and every 90 ft when the desired direction and deviation are obtained. Max depths are *ca* 10,000 ft. To avoid difficulty in removing cuttings from highly deviated holes an annular velocity of at least 120 ft/min is recommended. Oil emulsion muds with 10% crude oil are used to reduce torque. Trouble in getting wire-line tools to the bottom is expected where the deviation exceeds 60°.
J. C. M. T.

1110. How to catch better rotary cuttings. E. P. Roederer and H. T. Brundage. *World Oil*, April 1961, **152** (5), 65.—A new sample catcher has been field tested in S and offshore Louisiana. It automatically collects a representative of the entire formation being drilled and completely washes mud from the samples. Samples are thoroughly mixed, and the device is designed so that most lost circulation material is floated out of the top of the basket. Cuttings are dropped from the flow line on to shale shaker and then vibrated on to a collecting plate. They are water washed down the plate, which is fitted with two control arms which can be adjusted to control the vol of sample required, depending on drilling rate. Details of the equipment are given, and it has several advantages, since it tends to prevent the loss of data due to uncaught or mislabelled samples. It has a disadvantage in not being fully automatic.
C. A. F.

1111. Gulf Coast drillers whip the wall-sticking problem. E. McGhee. *Oil Gas J.*, 27.2.61, **59** (9), 100–3.—It is estimated

that ¾ of the fishing jobs occurring while drilling are caused by "wall sticking." This condition arises through the difference in pressure between the drilling fluid and the formation fluid in permeable formations and is liable to occur when drill pipe, etc., is allowed to remain stationary in contact with the wall. Drill collars are affected most commonly, owing to their large area of contact with the wall. Wall sticking is prevalent in the Gulf Coast region owing to the high mud wt and deep holes common there. The trouble is combated by: (1) using lighter muds; (2) using stabilizers and centralizers even in straight-hole areas; (3) using drill collars with a spiral groove on the outside; (4) keeping the drilling string in continuous motion; (5) using muds containing wetting agents; and (6) keeping water loss lower and filter cakes thinner in the muds. To free stuck pipe a weighted oil-base or invert emulsion mud is spotted in the stuck interval, and after 12–25 hr the string is jarred. J. C. M. T.

1112. Foreign rotary drilling approaches record. Anon. *Oil Gas J.*, 27.2.61, **59** (9), 81.—Total number of rotary rigs drilling outside the U.S.A., Canada, U.S.S.R., E Europe, and China in Feb 1961 was 839, *ca* half the number within the U.S.A. There were 420 operating in Latin America, 59 in the Middle East, 192 in W Europe, 109 in Africa, and 59 in India, Australasia, and Japan. The total number approaches the present record of 858 in June 1960. J. C. M. T.

1113. Foam agents and foam drilling. A. S. Murray and J. E. Eckel. *Oil Gas J.*, 20.2.61, **59** (8), 125–9.—Foam drilling is defined as drilling with air into which is injected a foaming agent and/or water, making a two-phase fluid system in which air is the primary phase. Normally 3–5 gal foaming agent in 10 brl water will produce a good foam; injection rates vary from 1–2 brl of mixture/hr to 1 brl/min. In competent formation foam drilling is economical at formation water influx rates of up to 500 brl/hr to depth of 4000 ft. Foam is not normally recovered, so cost of foaming agents must be low. Improved foaming agents are needed which would be equally effective in salt and fresh water, and soluble in very cold water. J. C. M. T.

1114. How to cope with desert drilling conditions. T. A. Aziz. *Oil Gas International*, March 1961, **1** (3), 25.—Drilling programmes and problems in the Zubair and Rumaila fields of S Iraq are described. Each well takes three to six months to complete with max depths at *ca* 11,800 ft. A 20-in hole is drilled to *ca* 200 ft, 15-in to 2200 ft, 10¾-in to 6000–8000 ft, and 7⅞-in is drilled to total depth. Mud programmes for each section are given. In the lowest section problems occur due to increasing wt and visc, high temp, and high pressure oil pays. High pH oil emulsion muds gave trouble due to high temp, but this was overcome by using lime-base fluids which showed little tendency to build up abnormal gels. Make-up water comes from the Shatt el-Arab. Oil base fluid is used only for coring in the Zubair pays for combating water invasion and to give more accurate determinations of connate water saturation. C. A. F.

1115. Ultra-deep fishing job in heaving-shale country. W. A. Hogan. *Petrol. Engr*, March 1961, **33** (3), B31.—A drill string stuck at 19,373 ft in a hole of 20,077 ft in heaving shale country in Louisiana. The operations and difficulties in recovering the drill pipe are given in great detail G. D. F.

1116. Air drilling for Abo pay. C. S. Adams. *Petrol. Engr*, April 1961, **33** (4), B82.—It is stated that air drilling has become one of the most important drilling methods in hard-rock drilling in the Abo formation, New Mexico. Contractors have obtained improved drilling rates and increased bit life. The air drilling programme, compressors and other equipment, and the maintenance of these are all outlined. Methods of fighting formation water are given, and air- and mud-drilling in the Abo formation are compared. G. D. F.

1117. Modern well completion series. Pt 11. Chemical treatment for well stimulation. F. N. Harris. *Petrol. Engr*, April 1961, **33** (4), B34.—Chemical treatment for well stimulation is shown to depend on the use of acidizing techniques and/or surfactants. The growth of chemical treatment over the years is reviewed. The greater part of the paper deals with acidizing, and this is followed by a section dealing with the types of acids and acid/surfactant mixtures commonly used. It is shown also that the use of acid as a perforating fluid is increasing and, finally, possible future trends in chemical well treatment are mentioned. G. D. F.

1118. How to maintain maximum hydraulic horsepower at the bit. G. Boudreaux. *World Oil*, April 1961, **152** (5), 91.—Modern drilling techniques aim at increasing penetration rate, and this can be achieved by proper control of the hydraulic system. The factors which control max hydraulic hp at the bit are discussed. This hp must be able to remove each chip as it is cut by the bit to prevent the regrinding which reduces penetration rate and bit footage, and the circulation rate or annular velocity must be high enough to carry the cuttings from the hole. A min annular velocity of 100 ft/min is usually adequate. Bit performance will be affected by pumping rate and type of nozzle, and two theories have been proposed to account for the relation between circulation rate and nozzle velocity to chip removal. One claims that the attainable rate of penetration varies with the impact produced at the nozzle, and the other that the hp expenditure of the jet stream below the bit controls the efficacy of the cleaning action. Jet bit principles with constant pump discharge are discussed, and diagrams showing hydraulic data for different hole sizes and drill pipe are included. C. A. F.

1119. Experience in Southeast Arabia shows how to choose the right log. D. J. Gregeen. *Oil Gas J.*, 27.2.61, **59** (9), 90–4.—In SE Arabia all formation waters at depths where oil is found have salinities over 160,000 ppm, and muds are either made with salt water or become salty by contamination. Formations consist of limestones and anhydrite. SP curves therefore have poor definition, and resistivity curves give little indication of hydrocarbon content. When possible, seven kinds of log are now run to combat these conditions. The electric log, though of little intrinsic value, is run for correlation with older wells. The Lateralog gives the best value of true formation resistivity, needed to find water saturation. The Microlog indicates qualitatively the presence of any porous intervals, and the MicroLateralog gives data for quantitative porosity determination. The γ-ray indicates the presence of shale and enables corrections to be made to the neutron and sonic logs, which are used for porosity determination. The section gauge is run to correct for hole size. No one log is reliable in all ranges of porosity and variation of fluid content, but a comparison of porosity values calculated from all available logs, together with any core analyses available, usually gives a good determination. J. C. M. T.

1120. Recent advances in logging techniques. The sonic log. C. A. Doh and L. A. Puzin. *World Petrol.*, March 1961, **32** (3), 45.—In sonic logging the time required for a sound wave to traverse a unit thickness of formation is continuously recorded *v.* depth. The tool comprises a transmitter, which emits energy pulses, and two receivers spaced apart on the sonde; there are many important uses of the log in geological, geophysical, and well completion problems. Excellent subsurface correlation can be obtained, and empirical equations permit porosity determination from sonic data. A novel use is the detection of faults and fractures by "cycle skipping," a feature due to the attenuation of sound signals which can be

recognized together with gas and fluid contacts. The geophysical applications are in seismic work, where accurate velocity data are required. In well completion the sonic log is used as a cement bond log in cased holes in order to detect annular cement distribution: a continuous recording is made of the amplitude of the sonic signals, min readings being obtained where there is best adhesion of cement to the casing. Examples of sonic logs are given. C. A. F.

1121. Chromates stabilize shale control muds at high temperatures. W. J. Weiss, J. S. Brukner, and C. O. Walker. *Petrol. Engr*, March 1961, **33** (3), B35.—In deep wells the problem of high temp becomes serious. Weighted drilling mud systems tend to be sensitive to high temp, and so are shale control muds. Various mud reactions at high temp are outlined. The development of a method of stabilizing the properties of shale control muds at high temp is studied. Composition effects, reversibility of high temp effects, high temp additives are dealt with. Shale control muds treated with anionic chromium cpds are found to be markedly less temp sensitive. Field evaluations and field applications are given in some detail. Safety precautions are mentioned briefly. G. D. F.

PRODUCTION

1122. Electrokinetic effects in laboratory permeability measurement. N. Street. *Prod. Mon.*, Jan 1961, **25** (1), 12–14.—The magnitude of the retarding effect on a liq flowing through capillary pores due to the streaming potential is discussed. The effect depends very largely on the conductivity of the liq. Calculated effects are in sufficiently good agreement with permeability measurements to indicate that the effect may account for the influence of salt concn on permeability measurements on cores which do not contain clay. G. B.

1123. Natural gas in Texas' industrial life blood. F. J. Gardner. *Oil Gas J.*, 13.3.61, **59** (11), 167.—Texas has 122·5 trillion cu ft natural gas, 44·8% of the U.S.A. reserves. 52% of the Texas reserves lie in the Gulf Coast region, 18·7% in the Panhandle, 13·5% in W Texas, and 13% in E Texas. 65% of the Texan reserves are in gas reservoirs not associated with oil. Production is from 16,771 gas wells and 192,627 oil wells. J. C. M. T.

1124. Fluid injection improves performance of Saudi Arabia's Abqaiq field. M. A. El Aouar. *Oil Gas International*, April 1961, **1** (4), 22.—Rapid pressure decline in the Abqaiq field of Saudi Arabia, together with high production rates and the formation of a secondary gas cap, have led to the introduction of water injection for secondary recovery. The field was discovered in 1940, and production is divided into two areas, A and B. A reached peak production in 1948 and B in 1950. Possibility of reservoir damage led to gas injection into the crest of A, and it is estimated that recovery in this area will be 54% instead of *ca* 35% under natural depletion. In area B it was decided that water injection on the flanks would give max recovery, and injection started in 1956. Water is now being injected through eight wells on the E flank, three on the W, and three on the nose area of B. Before the flood it was estimated that injection of 150,000 bd into these wells would increase production by 80,000 bd, but charts of subsequent production history since 1958 show that production rate has remained almost constant, although average reservoir pressure has increased.

Abqaiq consists of two elongated domes separated by a saddle, and area B forms the N dome. Flank dips are 3°–4°, increasing to *ca* 7° at the oil–water level. A has max closure of 1400 ft compared to 250 ft for B. Pay is Jurassic Arab D calcarenite, pelleted with some dolomitized oolite. Productive area is *ca* 110,000 acres. Tables give average reservoir properties for both areas, and a structure map is included. C. A. F.

1125. Water, gas injection boosts Kirkuk yield. S. M. Sims and T. I. Shafiq. *Oil Gas International*, March 1961, **1** (3), 29.—Water injection is to be carried out in the Kirkuk field of Iraq because of rapid pressure decline; at present gas is being injected into the crest. Pay is a fractured limestone *ca* 1000 ft thick and there are three domes at 1000–3000 ft in depth and trending NE to SW. Although only a small part of the original oil in place has been produced since the discovery in 1934, there has been a rapid pressure fall, indicating that the natural water drive is inadequate. Pilot water floods were started in 1957, and results indicate that an initial 750,000 bd of water will be required to balance an expected annual production rate of 36 million tons. To provide excess it is planned to inject a constant 1 million bd so that the scheme will be one of the largest water floods in the world. Water will be available from the Lesser Zab river, which crosses the structure. Four refs. C. A. F.

1126. Modern well completion series. Pt 10B. Permanent-type, multiple and tubingless completions. T. A. Huber and C. B. Corley, Jr. *Petrol. Engr*, March 1961, **33** (3), B57.—"Multiple completions" are defined, and the history of such completions is dealt with briefly. Dual completions are considered in more detail, four varieties being described. Tubingless completions are also described, with their advantages and disadvantages. The developments needed at present are listed. G. D. F.

1127. How to predict sand erosion perforating performance. R. W. Brown and J. L. Loper. *World Oil*, April 1961, **152** (5), 98.—Combined theory and practical experience has indicated that sand erosion perforating performance can be predicted, and it is shown that max penetration is strongly influenced by the power supplied to the bit, formation hardness, and perforation size. Performance is also affected to a lesser degree by nozzle stand-off distance, sand concn, and back pressure. Equations are developed for penetration into cased and open formations, and curves show relationship of penetration *v.* time for formations of varying hardness. Tests were carried out on limestones, dolomites, and sandstones from Texas, Utah, Illinois, and Louisiana. Three refs. C. A. F.

1128. New production facility automated from well head to pipeline. R. H. Peacock. *World Oil*, April 1961, **152** (5), 86.—An automatic tank battery recently built offshore from S Louisiana is described in detail. It serves 13 producing units with a total of 24 wells producing a combined allowable of 1783 bd. Main equipment consists of a stacked separator production unit, where all oil and gas is metered before mixing, a 1500-brl storage tank, two emulsion treaters, and a skid-mounted automatic custody transfer unit. Automatic well testing equipment is also fitted. Advantages over a conventional battery are listed, and it is shown that it provides a smaller and more compact unit with lower maintenance costs. Total cost was approx $203,000. C. A. F.

1129. How pH controls contaminated flood waters. G. C. Bernard and H. L. Chamberlain. *Oil Gas J.*, 20.3.61, **59** (12), 156–7.—Precipitation of iron sulphide in mixed flood waters can be prevented by moderate adjustment of pH. The solubility of iron sulphide in water depends theoretically on the square of the hydrogen ion concn. In lab experiments brines at various pH values in which hydrogen sulphide was dissolved were mixed with ferrous ammonium sulphate and passed through a sintered disk; these confirmed that the plugging effect followed the theoretical predictions qualitatively. Field tests were then carried out. The mixed waters contained 4 ppm dissolved iron and 20 ppm of sulphide respectively.

By the addition of sulphuric acid the pH was held between 5·6 and 5·8. A corrosion inhibitor was also added at the rate of 8 ppm. This water has been injected satisfactorily for 18 months. Cost of chemicals is *ca* $1·1/1000 brl water.
J. C. M. T.

1130. Field testing of corrosion inhibitors in sea water. C. C. Wright. *Prod. Mon.*, Jan 1961, **25** (1), 18–19, 27.—Sea water taken from near the surface has been tested for suitability for injection into the Wilmington field. After the removal of O by means of excess Na_2SO_3, filtration through diatomaceous earth, and addition of corrosion inhibitor, the water was satisfactory for the purpose. G. B.

OILFIELD DEVELOPMENT

1131. How closely is U.S. wildcat drilling controlled by seismograph? Anon. *World Oil*, April 1961, **152** (5), 72.—Charts are presented showing the history of wildcat drilling in the U.S.A. from 1937 to 1959 and a history of seismograph crew-months over the same period. Both show good correlation and indicate that the number of wildcat wells drilled in any year is generally influenced by the amount of seismic work done four years before. Although U.S. wildcatting may continue to decline, exploration techniques are improving, and a higher proportion of wildcats should be completed as producers in the future. C. A. F.

1132. Water flood prediction comparisons. H. C. Slider. *Petrol. Engr*, April 1961, **33** (4), B78.—This brief section presents two figures omitted from the author's paper in the Feb issue (*cf* Abs. **808**, 1961), and the discussion of these figures.
G. D. F.

1133. Alabama's deep future hinges on Citronelle test. F. J. Gardner. *Oil Gas J.*, 8.5.61, **59** (19), 131.—One of two recent deep wildcats in Alabama has been unsuccessful and was abandoned at 18,741 ft after penetrating Jurassic Smackover and reaching salt. The second well is under way in the S–Central part of Citronelle with the aim of testing the pre-Cretaceous. Soft sand was found in the Jurassic Cotton Valley at *ca* 16,000 ft. No deep fields have been found in Alabama since Citronelle in 1955. C. A. F.

1134. Economic, physical factors and the Arctic future. H. Nielsen. *Oil in Canada*, 23.2.61, **13** (16), 34–8.—The prospects of finding highly productive oilfields are very good. The climatic and topographical conditions present fewer problems than those of the NW Territories. The initial move of people and equipment would be difficult until centres of population had been established. The cost of transporting oil to possible markets could be less than that from other oilfields. The existing regulations and tax system are such that the necessary investment capital is not attracted. G. B.

1135. Directory of North African oil concessions. Anon. *Oil Gas International*, April 1961, **1** (4), 31.—Oil concessions and permits have now been taken out across most of the area between the Spanish Saharan coast and the Egyptian coast over a distance of some 2500 miles. There has been rapid expansion in exploration and development in N Africa since *ca* 1955, and there have been successive major finds in Libya and the French Sahara. Concessions in Libya are, however, being given up periodically under a rule that 25% of each concession must be relinquished after five years. Details are given of concessions in Algeria, French Sahara, and Libya, together with permit maps. C. A. F.

1136. Communist oil: 1961 and 1965–1975. Anon. *Oil Gas International*, April 1961, **1** (4), 36.—Recent oil developments and prospects of future production in Communist areas are reviewed. Production in countries outside Russia in 1960 was 431,350 bd, and by 1975 it is expected to increase to *ca* 1,350,000 bd. Refining capacity is not, however, keeping pace with the rise in production, and there are plans to build 60 refineries over the region during the next 15 years. Details are given of production, exploration, and reserves for Albania, Bulgaria, China, Czechoslovakia, E Germany, Hungary, N Korea, Poland, Mongolia, Rumania, Russia, and N Vietnam.
C. A. F.

TRANSPORT AND STORAGE

1137. Coal-in-oil pipelining. N. Berkowitz *et al.* *Oil in Canada*, 19.1.61, **13** (11), 25–9.—A lab study with a 1-inch, 45-ft pipe is reported. Pulverized coal in concn up to 35% by wt under the same conditions as for oil alone. Higher concn increase the pressure gradients but do not block the line. Normal oil velocities in the pipeline are sufficient to prevent settling of the solids. In the system studied the coal passes through the pumps and suffers further comminution, so that this method is applicable only to finely pulverized coal. The problems of abrasion of the pipe and pumps and of subsequent separation have not yet been studied. The saving in transport cost from Alberta to Ontario would be from 50 to 66%.
G. B.

1138. Construction equipment survey of gas transmission, crude/products trunk lines, pipeline contractors. F. H. Love. *Petrol. Engr*, March 1961, **33** (3), D28.—The results are given of a survey of construction and maintenance equipment utilization and replacement in the fields listed above. A very great deal of information is provided in a very compressed form which defies further abridgment. G. D. F.

1139. Plastic pipe in oil and gas fields. H. S. Pylant. *Oil Gas J.*, 27.2.61, **59** (9), 82–4.—Although producing companies are not quite as enthusiastic about the applications of plastic pipe as the manufacturers, 25% more was installed in 1960 than in 1961. Corrosion resistance is the main reason for turning to plastic pipe, although other factors, such as the alleviation of scale and paraffin build-up, are considered. The most popular material for plastic pipe is acrylonitrile–butadiene–styrene (ABS), followed closely by linear polyethylene (PE).

Approx 38% is being used for crude gathering lines, and more than half of this is ABS. Gas gathering lines account for 24%, with PE making up 95% of this category. Salt-water disposal systems used 32%, and ABS is the leader in this application. A. D. S.

REFINERY OPERATIONS

REFINERIES AND AUXILIARY REFINERY PLANT

1140. Pumps for technical process plants. (In German.) W. Buschhorn. *Chem. Ing. Tech.*, 1961, **33**, 237–43.—Operating safety (both as regards constructional design and also in the selection of materials) is a very important requirement of pumps in technical process plants. General constructional principles, the choice of materials of construction from the point of view of corrosion resistance, etc., and economic aspects are considered. Taking into account the various considerations, a description is given of the way in which

industrial standard series of pumps have been produced. There are a number of photographs illustrating effects of corrosion, etc. G. D. F.

1141. New developments in valves for high-pressure plant. (In German.) O. Konrad. *Chem. Ing. Tech.*, 1961, **33**, 195–204.—" High pressure plant " here is taken as plant operating at pressures above 100 atm gauge. It is shown that it has been possible to construct lighter and smaller high pressure valves by the inclusion of self-sealing seals of fluorocarbon plastics. The smallest possible types of construction are dealt with, as are types of packing rings. Control requirements may also influence the construction. The paper concludes with a lengthy section considering various types of valves, *e.g.* angle valves, poppet valves, non-return valves, etc; there are numerous drawings, sketches, and photographs. G. D. F.

1142. Industrial heat transfer media for temperatures up to 400° C. (In German.) J. Szymkowiak. *Chem. Ing. Tech.*, 1961, **33**, 243–5.—The reasons for using heat-transfer media are outlined, and the desirable properties of such media are mentioned. This paper is particularly concerned with the material Diphyl (trade mark of the Farbenfabriken Bayer AG), which consists of 26·5 wt % diphenyl and 73·5 wt % diphenyl oxide. The physical properties of this material are given as a function of temp (20°–400° C). The equipment required for the use of Diphyl is dealt with for the cases of cooling and heating. The pyrolytic changes occurring in Diphyl and its regeneration are outlined, and finally there is an example of its use. G. D. F.

1143. 47 selected processes for obtaining more and better refined products. Anon. *Oil Gas J.*, 3.4.61, **59** (14), 115–62.—The 47 processes described all deal with product improvement. Most deal with gasoline fractions, some with middle-brl dist, and others with residual stocks. With the commercialization of hydrocracking and the much greater use of hydrogen for removing sulphur and other contaminants from dist streams, it is not surprising that 14 processes are concerned with these aspects. Two processes dealing with hydrogen manufacture are also included. A. D. S.

1144. Two-phase flow through horizontal pipes. (In German.) Yap Kie Jan. *Chem. Ing. Tech.*, 1961, **33**, 184.—The article is a brief description of a ciné-film (with sound) of two-phase flow through horizontal pipes, such as occurs in refinery pipe-stills. The film was prepared at the Koninklijke/Shell-Laboratorium, Amsterdam. G. D. F.

1145. Annual survey of capacities of U.S. refineries. R. B. Bizal and K. W. Brooks. *Oil Gas J.*, 3.4.61, **59** (4), 164–88.—The location and capacities of U.S. refineries are presented by state and show a daily crude capacity of 9,933,000 brl. A detailed account of the plants, their capacities, and the types of processes involved is given in tabular form. A. D. S.

1146. Annual survey of capacities of Canadian refineries. Anon. *Oil Gas J.*, 3.4.61, **59** (4), 185–8.—Tables are presented of the location and capacities of Canadian refineries by state and also of the companies concerned, together with the types of process involved. A. D. S.

1147. New projects in the works at 50 refineries. Anon. *Oil Gas J.*, 3.4.61, **59** (4), 189–92.—This survey shows 62 projects recently completed, under way, or planned. *Ca* 12 of these are long-range plans for new refineries, and construction has not actually been scheduled for them. Of the 50 active projects, 46 are in the U.S.A. and four in Canada. A. D. S.

DISTILLATION

1148. Try the pseudo-K method for short-cut multi-component distillation calculations. R. N. Maddox and W. A. Fling, Jr. *Petrol. Engr*, March 1961, **33** (3), C37.—A rapid and convenient way is given for predicting dist tower performance without use of a computer. Equations are set up, and it is shown that the results obtained in this way agree well with test results and rigorous calculations. G. D. F.

1149. How to calculate minimum reflux for multi-component columns. R. C. Erbar, R. S. Joyner, and R. N. Maddox. *Petrol. Engr*, March 1961, **33** (3), C19.—It is shown that the common procedure for solving the Underwood equations for calculating the minimum reflux ratio is incorrect on several points. Underwood's equations are rearranged to a more convenient form, and a method for the proper use of these equations is outlined. The procedure is illustrated by a sample problem. G. D. F.

1150. Constructional form of two vacuum columns of large dimensions with air-cooled condensers. (In German.) J. Dodt. *Chem. Ing. Tech.*, 1961, **33**, 205–9.—Two large-dia vacuum columns (top pressure is 40 mm Hg) have been constructed recently in an extension of the styrene plant at the Chemische Werke Hüls AG. These have 46 bubble-cap trays each, and air condensers. A number of special features, including the tray construction, and the arrangement of the air condensers are shown to open up interesting possibilities for the design of dist plant. G. D. F.

1151. Distillation in view of modern developments. Pt 2, Chap 2e. Theory of fractionation, ternary distillation. K. F. Gordon and J. A. Davies. *Petrol. Engr*, April 1961, **33** (4), C28.—It is shown that the graphical solutions of binary and ternary dist problems are important because they show pictorially the factors which are important. Here the relations for simple ternary systems are dealt with by means of triangular diagrams. The method is then extended to charge-reflux and charge-reboiled columns, azeotropic dist, extractive dist, fractionation near the critical point, and two liq phase fractionation. G. D. F.

1152. The function and construction of distillation columns. (In Dutch.) B. Goedhuis. *Ingenieur, 's Grav.*, 17.3.61, **73** (11), W39; 31.3.61, **93** (13), W55.—A review of dist columns is given as used in the petroleum industry. Formulæ are given for the calculation of column wall thickness, support thickness, and anchor bolt strength. Details of base design, inlet and outlet construction, and the problems of stress relieving are considered. The physical behaviour of the liq and vapour phases in columns equipped with bubble caps is described in detail, in particular the fluid gradient, pressure drop, down-cover requirements, inter-tray spacing, etc. The construction and behaviour of the various types of bubble caps are also given. Similar details concerning the manufacture, design, and operation of sieve trays, turbogrid trays, ripple trays, flexitrays, and shower decks are also given. 25 diagrams are included. D. C. E. de W.

SOLVENT EXTRACTION AND DEWAXING

1153. Liquid extraction. Unit operations review. R. E. Treybal. *Industr. Engng Chem.*, Feb 1961, **53** (2), 161.—While the past year has seen some important fundamental work in the field of liq extraction, the actual progress towards understanding the underlying phenomena has been slow. In the research field there is a trend away from studies of small lab towers and an increasing tendency to study liq–liq interfacial and drop phenomena. Most promising research involves problems of interfacial turbulence. The first detailed

study of a vibrating-plate extractor and renewed interest in the rotating-cyl extractor mark the year's progress.

In the field of petroleum chemistry there have been important developments by Sinclair Petrochemicals (purification of *iso*-amylenes), Humble Oil's work on phenol extraction of cat cracker gas oil to remove aromatics, and many others referred to in this review. M. F. M.

CRACKING

1154. Technical flow model experiments on oil cracking plants. (In German.) G. Hilgers and R. Wille. *Chem. Ing. Tech.*, 1961, **33**, 251–4.—The paper deals with the thermal cracking of oil to give, *e.g.* synthesis gas or town gas. A turbo-gasifier is described, which possesses a rotating impeller in the gasification chamber. The mixing action of the impeller has an important effect on the course of the process. In order to find the most suitable design for the gasification chamber, model tests were carried out using dye streams for determining the flow and mixing processes. Several interesting photographs are given. G. D. F.

1155. Production of acetylene and ethylene from hydrocarbons of the benzene fraction. (In German.) Anon. *Chem. Ing. Tech.*, 1961, **33**, 248–50.—Various methods for the production of acetylene and ethylene from liq hydrocarbons are reviewed briefly. The SBA–Kellogg process is dealt with in more detail, including the effect of various operating variables, and the relation between the output and these variables. Experimental results are presented, discussed, and compared with those for other processes. Finally, treatment of the cracked gases is dealt with. G. D. F.

HYDROGENATION

1156. Thermal hydrogenation of crude residua. A. W. Langer *et al.* *Industr. Engng Chem.*, Jan 1961, **52** (1), 27.—A thermal hydrogen transfer process was developed for crude residua to avoid deactivation problems inherent in cat processes and to minimize the excessive degradation to coke and dry gas encountered in coking processes.

Practical hydrogen donor diluents were prepared by partial hydrogenation of low value refinery streams containing high concn of condensed ring aromatics. Liq phase thermal cracking of residuum in the presence of such diluents gave essentially complete conversion with little degradation to coke and dry gas. Hydrogen consumption was below 400 cu ft/brl of residuum.

Hydrogen donor diluent conversion process (HDDC) involves thermal cracking, dist, and low pressure hydrogenation with sulphur insensitive cat. It is broadly useful for all residual stocks, including asphalt, shale oil, and tar sand. M. F. M.

POLYMERIZATION

1157. Polymerization. Unit process review. F. H. Bolton. *Industr. Engng Chem.*, Jan 1961, **53** (1), 79.—During the review year (1959) many interesting advances were made in the field of ionic catalysis and stereoregular polymers, initiation of polymerization by radiation, and the preparation of block and graft co-polymers. Graft polymers were prepared by free radical polymerization in a soln of pre-formed polymers. Search continues for inorganic polymers of practical utility. The review includes references to emulsion and suspension polymerization and also condensation polymerization. M. F. M.

SPECIAL PROCESSES

1158. Direct hydration of olefins with cation exchange resins. R. C. Odioso *et al.* *Industr. Engng Chem.*, March 1961, **53** (3), 209.—The authors show that at selected low temp (150°–250° F) and low pressure (150–425 psig) conditions, 27–32 mol % of the *iso*butylene content of C_4 refinery streams and 10 mol % of the *iso*amylene content of a C_5 refinery stream were selectively converted to *tert*-butyl and *tert*-amyl alcohols respectively, by direct hydration using a cation exchange resin cat. Cat activity was maintained for long process periods.

This method, coupled with dehydration, affords an economical means of preparing pure alcohols or pure *iso*-olefins from refinery streams. M. F. M.

1159. Chemicals from methane in a high compression engine. P. E. Oberdorfer and R. F. Winch. *Industr. Engng Chem.*, Jan 1961, **53** (1), 41.—Using a high compression engine as a chemical reactor is a means for getting short reaction times, high temp and pressures, with rapid quenching. Such engines may be used for partial oxidization of rich methane–oxygen mixtures under controlled conditions. The tests described in the paper showed that the chemical products of oxidn in order of amounts were: methanol, formaldehyde, and formic acid, totalling up to 50% of the methane converted. CO and H_2 were also formed.

The higher hydrocarbon components present in small amounts in natural gas were selectively dehydrogenated to the corresponding olefins. M. F. M.

METERING AND CONTROL

1160. Process instrumentation symposium. Various. *Petrol. Engr*, April 1961, **33** (4), C4–27.—A number of brief papers on instrumentation in the hydrocarbon process industries (HPI) are presented, namely: (1) Instrumentation—an efficient money-maker, R. E. Hughes, C4–6; (2) Instrumentation trends in HPI, A. H. Schutte, C7–8; (3) SAMA—an organization that works for you, Anon, C9–11 (SAMA = Scientific Apparatus Makers Association); (4) Instrument gadgeteering —sound practice or waste of time? C. R. Miller, C12–13; (5) Instrumentation—too much or too little?, E. J. Byrne, C14–15; (6) Closed-loop chromatographic control optimizes de-ethanizer performance, D. J. Fraade, C16–18; (7) Control of integrated steam and process facilities, W. S. Bowers, C22–7. G. D. F.

1161. Instrumentation, controls, and automation. Pt 5. Telemetering. M. T. Nigh. *Petrol. Engr*, April 1961, **33** (4), D29.—This section deals with digital telemetering and the language patterns used. The various terms used are defined. Various language patterns for telemetering machines, codes, etc., are dealt with. G. D. F.

1162. Interkama 1960. Recent developments in measuring and control apparatus for the chemical industry. (In German.) *Chem. Ing. Tech.*, 1961, **33**, 254–82.—Interkama, the International Congress with Exhibition for Measurement Technology and Automation, took place in Düsseldorf from 19 to 26 Oct 1960. Reports are given in the following fields:

1. **Electrical controllers.** H. Bürklin (pp 255–60). Quite a number of electrical controllers and controller/recorders are described, and the interesting points of each are discussed. Among these are transistorized models, midget models, and many others.

2. **Pneumatic and electro-pneumatic controllers.** G. Pressler (pp 260–6). Various pneumatic or electro-pneumatic controllers for potential, derivative, and integral action, together with recorders, are discussed. Many of the latest developments by Continental, British, and American firms in this field are included.

3. **Digital measurement recording and processing.** G. Schüngel (pp 266–70). It is shown that automatic recording

and processing of data offers many advantages. The methods of operation of such systems is outlined, and various commercial instruments and their application to specific types of problems are discussed. Methods of presenting the final data are mentioned briefly.

4. **Laboratory measuring apparatus.** F. Merten (pp 271–80). Various recent developments in the following fields are mentioned, and this is followed by a discussion of various commercial models of the equipment for the purpose: gas chromatography; mass spectrometry; and ir and uv spectroscopy.

5. **Automatic analysis equipment in plant operation.** H. Hummel and J. Ebert (pp 280–2). Various types of automatic analysing equipment are discussed under the following headings: measurement of radiation absorption; measurement of heat conductivity, gas density, etc; gas analysis after chemical reaction; automatic gas chromatography; and continuous liq analysis by various methods. G. D. F.

1163. Analogue computer-controller for capacity control of a distillation column. W. O. Webber *et al. Proc. Amer. Petrol. Inst.*, 1959, **39** (3), 114–19.—An analogue computer has been designed, built, and operated to control a commercial dist column to capacity vapour rate. It computes the actual vapour rate from measured reflux and product rates, the vapour capacity as a function of measured pressure, and, finally, the percentage of vapour capacity actually utilized as a quotient. The finally computed percentage is recorded and can be used to control the tower to any desired percentage of capacity. (Author's abstract.)

PRODUCTS

CHEMISTRY AND PHYSICS

1164. Entropies of vaporization of hydrocarbons and the Hildebrand rule. R. W. Hermsen and J. M. Prausnitz. *J. Chem. Phys.*, 1961, **34**, 1081–3.—Many years ago, Hildebrand suggested that the entropies of vaporization of nonpolar fluids are essentially equal when comparison is made at the same saturated vapour vol. Hildebrand's calculations have been repeated in the light of the most recent information for a series of hydrocarbons, and the values reported here show that all normal paraffins from C_1 to C_{20} have essentially the same entropy. Branched paraffins show deviations which appear to increase with the extent of branching. G. D. F.

1165. Demulsification by the use of ion-exchange resin membrane. K. Shinoda. *J. Coll. Sci.*, 1961, **16**, 85–7.—An emulsion comprising 40% vol *n*-heptane and 60% vol aq sodium dodecyl sulphate soln (conc 0·0043% wt) was placed in a 5-mm thick cell with walls of anion or cation exchange resin membranes. The cell was placed in a N/4 NaCl soln and a dc current applied through a Pt anode and Ni anode. At 15 v and 0·11 amp/dm² the emulsion was destroyed after 10 min, whereas it remained stable for 48 hr in its original condition. H. C. E.

1166. Bubble formation at an orifice in a fluidized bed. D. Harrison and L. S. Leung. *Nature, Lond.*, 1961, **190**, 435.—Particles of sand (0·01 cm dia) or alumina (0·0057 cm dia) were fluidized in a 6-in dia tube with an air stream. An independent air stream at known flow rate G was passed into the bed *ca* one-third up from the distributor from an orifice which was fitted with a probe. The frequency of bubbles from the orifice was measured by recording on an oscilloscope the change in capacitance between the probe and one placed *ca* 3 cm above it in the bed. The bubble vol was calculated from the frequency and the flow rate. Up to flow rates of 10 ml/sec the bubble vol V corresponded with that obtained from the equation $V = 1{\cdot}378\ G^{1{\cdot}2}/g^{0{\cdot}6}$ (where g is the gravitational acceleration) obtained theoretically from a study of the formation of a gas bubble at an orifice in an inviscid liq; above this value the experimental values were smaller than the calculated values. The bubble frequency is largely independent of bed height, main air flow rate to the fluidized bed, and nature and size of the particles. H. C. E.

1167. Nature of the reactions involved in the pyrolysis of *n*-butane inhibited by propylene. J. H. Purnell and C. P. Quinn. *Nature, Lond.*, 1961, **189**, 656–8.—The technique of high-speed GLC in conjunction with a high-sensitivity flame-ionization detector has been used to study the uninhibited pyrolysis of *n*-butane, and the reaction in the presence of propylene. It was found that the product ratio [methane/(ethane + ethylene)] was independent of the propylene pressure. Some results are given for pyrolysis at 779° K and butane pressure 19·2 mm and the propylene pressure varying from zero to 30 mm. It is shown that the product ratio α = ethylene/ethane increases linearly with propylene pressure, and the extrapolation of this line to zero propylene gives a value of α identical with that of the uninhibited reaction.

The hypothesis that radical and mol processes occur concurrently in the uninhibited reaction is examined and shown to be false, and it is concluded that both uninhibited and inhibited reactions are entirely free-radical in character. The inhibited reaction is best described in terms of a modified free-radical chain reaction propagated by radicals of low reactivity. H. C. E.

1168. Detection of free charges from motor car exhaust gases. T. Westermark. *Nature, Lond.*, 1961, **189**, 910.—The existence of free charges in the exhaust gases of some 40 IC engines has been demonstrated. Production is low when the engine is first started, but rises to a steady high state (*ca* 10^7 charges/sec) at full throttle. Individual engines give widely different results: in the worst 10^{14} charges/sec were obtained, corresponding to a current of 10^{-4} amp; small engines yield a current of 10^{-9} amp. The charges are confined to the gas cloud, and decrease steadily as the distance from the exhaust pipe increases.

The origin of these charges is briefly discussed. One possibility is that they are due to the presence of gaseous ions. H. C. E.

ANALYSIS AND TESTING

1169. A simple method to detect sulphate reducers and evaluate bactericides in flood water. F. Yackovich. *Petrol. Engr*, April 1961, **33** (4), B48.—The paper reports satisfactory tests on a procedure for detecting sulphate-reducing bacteria in flood waters by means of field tests; it is claimed that the method is simple, inexpensive, reliable, and reproducible, and that the results are easily interpreted. The preparation of the materials and equipment is described in some detail, as is the field test procedure. Bactericides can also be evaluated. Tests carried out on metal surfaces are also described. G. D. F.

1170. Rapid method for the determination of tetramethyl lead and tetraethyl lead in petrol. J. van Rysselberge and R. Leysen. *Nature, Lond.*, 1961, **189**, 478.—250 ml of gasoline are dist in a 30-cm Vigreux column into four fractions: <100°, 100°–125°, 125°–150°, 150°–175° C, and a residue. The second fraction contains the TML, and the residue contains the TEL. The lead is determined by examining the

fractions in a flame spectrophotometer at 406 mμ. Results are given for an experimental platformate and for commercial gasolines. H. C. E.

1171. Gas chromatographic separation of low-boiling hydrocarbons using active alumina as support for the liquid phase. L. Halasz and E. E. Wagner. *Nature, Lond.*, 1961, **189**, 570.—Column packings having alumina as supporting phase are superior to those having an inactive support. The stationary phase is made by calcining $\gamma Al(OH)_3$ for 9 hr at 400° C, adding a suitable liq dissolved in a solvent which is subsequently evaporated off, and drying for 5 hr at 70° C. During the final drying samples treated with polar liq undergo a wt loss which is attributed to the release of chemically-bound water. Suitable liq are squalene, triethylene glycol, and ββ′ oxydipropionitrile (I).

Using alumina impregnated with 18% of I, all hydrocarbons in the range C_1–C_4 can be separated on a 2-m column at 0° C using hydrogen as carrier gas. Hydrocarbon mixtures up to C_7 have also been successfully separated. H. C. E.

CRUDE OIL

1172. Proton relaxation in crude oils. R. J. S. Brown. *Nature, Lond.*, 1961, **189**, 387.—Thermal relaxation, visc, and density data were obtained for 12 Texas and two Californian crudes. Temp were varied from 3° to 100° C and field strengths from 0·02 to 7000 gauss. It was found that the relaxation time T_1 was strongly correlated with visc but only weakly correlated with density. T_1 for a given crude showed no discontinuity at the pour pt, even though the visc changes drastically.

In only one sample was T_1 strongly dependent on field strength; at very low field strength the thermal relaxation rate $(1/T_1)$ was equal to the transverse relaxation rate, and fell at higher field strengths. If some of the relaxation is due to the presence of free electrons, frequencies of electron precession may be involved in the observed decrease in $1/T_1$. H. C. E.

GAS OIL AND FUEL OIL

1173. Oil firing experience in the power stations of Great Britain. W. D. Jarvis. *Ingenieur, 's Grav.*, 17.2.61, **73** (7), W29.—The article deals with coal-fired steam raising boilers of the British Electricity Authorities which have been converted to oil firing. The residual fuel oil used in this equipment gave rise to loss of superheat temp, low and high temp corrosion, and the emission of acid-laden dust. Loss of superheat temp due in part to the reduced vol of flue gas with oil firing was remedied by the suitable arrangement of refractories in the combustion chamber. Better design of boiler, superheater, and burner equipment would achieve the design temp required and would eliminate the high temp corrosion due to flame impingement. The worst trouble due to oil firing was low temp corrosion in the air heaters, ducting and precipitators due to the presence of SO_3, water vapour, and free O_2 in the flue gases. Adjustment of the CO_2 content of the flue gases and trials with dolomite, magnesium carbonate, and powdered zinc as additives to the oil helped to suppress the corrosion and the emission of acid smuts, but increased the blockage rate of the air heater equipment. General operating experiences are included and compared to coal firing experience.

D. C. E. de W.

LUBRICANTS

1174. Lubrication. Anon. *Mech. Pwr*, 1961, **57**, 51–3.—Meeting of the Institution of Mechanical Engineers, Birmingham, Feb 1961. Five papers were presented: Lubrication of Free-Piston Gas Generators, Piston Ring Wear in Automotive Gasoline Engines, Connecting-rod Big-end Bearing Design Factors, Materials for Unlubricated Journal Bearings, and Recticular Tin–Aluminium Bearings.

The first paper was concerned mainly with lubrication problems on the free-piston gas engine. The second showed that, whereas in the past the wear of piston rings was predominantly due to corrosion, now that engine temp are thermostatically controlled, corrosion is responsible for only a minor part of piston ring wear. This allows for much more scope in varying the components of lub oils. Of the remaining papers, the outstanding development is the use of a bearing metal consisting of an aluminium alloy containing 20% tin.

H. C. E.

1175. Improved lube oil anti-oxidants. G. G. Knapp and H. D. Orloff. *Industr. Engng Chem.*, Jan 1961, **52** (1), 63.—A method has been devised for measuring the anti-oxidant effectiveness of mixtures of hindered phenols and dialkyl phosphonates. The anti-oxidant effects obtained with such mixtures have been correlated with the structure of both materials, and a mechanism has been proposed. A preferred combination is 4,4′-thiobis-6-*tert*-butyl-*o*-cresol and di-*sec*-butyl phosphonate. All tests have shown that these two materials provide excellent anti-oxidant effectiveness as well as good anti-wear properties to lub oils. M. F. M.

1176. Crankcase lubricating oils for locomotive diesels. Anon. *Gas Oil Pwr*, 1961, **56**, 71.—Synopsis of two papers read to the Institution of Locomotive Engineers, Jan 1961.

The first paper deals with spectrographic analysis of crankcase lub oils, to determine the amount of wear of working parts. Emission spectrography is employed, and the oil sample may be first ashed to concentrate the metals to be determined, or the sample may be used without preparation. A valuable feature of this type of analysis is that warning may be given of impending engine failure.

The second paper deals with quality control of lub oils during service. The value of periodic determination of visc, fuel dilution, acidity, etc., is assessed in relation to the progressive degradation of the oil during use. It is stated that a sudden increase in the total acid number not accompanied by an increase in the strong acid number is an indication of undue oil oxidn, and this may be confirmed by the difference between the pentane insoluble matter and benzene insoluble matter.

H. C. E.

BITUMEN, ASPHALT, AND TAR

1177. Adhesive power of bituminous binders. (In German.) W. Riedel. *Bitumen, Teere, Asphalte, Peche*, 1959, **10**, 292–5.—Binder resistance to tensile stresses is applied for cleavage testing. To detect small differences between binders, sensitivity is investigated at 25°, 30°, and 35° C. In tensile testing sensitivity varies with temp. Tensile tests are reported on samples of identical composition and under the physical conditions adopted for cleavage tests. Comparative curves are presented. Based on the test results a definite val for all loading conditions and temp-valid cohesion does not exist. All most probable cohesion val lie in the range of magnitudes somewhat below 100, 500, or 1000 kg/cm². Approval and visc–temp val do not run parallel, but a connexion is observable between approval and tensile strength. Since cohesion val presents an extreme val of tensile strength, cohesion of a road covering depends directly on the binder. Under traffic shocks, tension loads >60 or 100 kg/cm² can arise, emphasizing the binder cohesion. In all tensile tests in which loading time is not infinitely small, flow within the binder may occur. Under traffic effects—shear, tension, or impact—hair cracks may occur, which heal with adequate binder. The three binder properties—visc, cohesion, and

adhesion—are equally important, and all together determine the properties of a binder. R. T.

1178. Surface-active additions to bituminous road building materials. (In German.) Anon. *Bitumen, Teere, Asphalte, Peche*, 1959, **10**, 344–6.—Abstracts from the Soviet Union road-building literature for improving road surfaces by sp additive additions are presented and discussed. R. T.

1179. Briquetting with petroleum bitumen as binder. (In German.) P. Zakar and J. Toth. *Bitumen, Teere, Asphalte, Peche*, 1959, **10**, 358–60.—The most important cost factor in briquette production, after coal, is the binder. Requisite bitumen properties are presented and discussed. Generally, a bitumen is preferred which—at a given pen—possesses a low soft pt, which, however, should be not under *ca* 60°. A suitably selected bitumen is shown to be equivalent to coal tar pitch as briquette binder. Careful atomization of the bitumen at high temp is advantageous. R. T.

1180. Bitumen composition. (In German.) G. Ziehmann. *Bitumen, Teere, Asphalte, Peche*, 1959, **10**, 377–81.—This investigation conveys an important explanation on molecular changes which occur on blowing or exposing a bitumen to a high temp (thin film oven test). It is shown to be desirable to distribute the bitumen into somewhat definite fractions. Spectrometric analytical methods make possible characterization of hydrocarbon types present. P + N (paraffin + naphthene) fraction in quantity and character remains relatively const if a bitumen be subjected to these two processes. The aromatic oil fraction, on the other hand, shows a relatively strong reactivity, which is expressed by conversion into asphaltenes. During the blowing process the system of highly-condensed aryl groups with short side chains appears to react first. If the "thin film hardening test" be undertaken, the mol with a smaller number of aryl groups and low mol wt react preferably. The asphaltenes are characterized basically through their mol wt, a highly-aromatic character, and by a highly-condensed system with more than one aryl group/mol. Some mutual reactions between the asphaltenes are observed if a bitumen be blown. Obviously a further characterization of the chem structure in this way will assist in clarifying the reactions occurring when a bitumen changes through weathering, natural aging, or overheating. 25 refs. R. T.

1181. Impact bending test for bitumen with a swinging hammer mechanism. (In German.) S. Vajta and L. Fajta. *Bitumen, Teere, Asphalte, Peche*, 1959, **10**, 396–401.—A pendulum-hammer striking apparatus has been designed for impact bend testing of bitumen on samples 2·5 × 1·5 cm. This method is suitable for estimating the characterizing sp impact work (cm kg/cm²) for mechanical properties of the tested bitumen, or, in case of similar normal test bodies, the impact work (cm/kg). Necessary apparatus for preparing test samples is illustrated, and testing technology is presented. The method is suitable equally for testing highly-elastic (*e.g.* rubber bitumen) and brittle (*e.g.* briquette bitumen). Testing data are tabulated. R. T.

1182. Tar and asphalt mixed macadam as ingredient of foundation construction of roads. (In German.) T. Temme. *Bitumen, Teere, Asphalt, Peche*, 1959, **10**, 456–9.—Many reports have appeared in the literature on various procedures adopted and their sp advantages. In considering constructions the nature and suitability, also cost, must be examined for the particular case in view. In impact and percussion effects of traffic, part of the energy is reflected, causing noise. Another part is absorbed by the covering; a third part is transmitted to the road foundation. A bitumen-bound surface surpasses all others in absorbing impacts and vibration. This affects buildings in streets, and is a property of all bitumens. Mixtures containing bitumen are superior to those containing none. Advantages and disadvantages of rounded and broken stone are discussed. Use of bituminous mixed-macadam is advantageous in the upper bearing strata of the underground construction. Mixtures are made with stone granulation max 45 mm for hot application. R. T.

1183. Harmlessness of asphalt as floor covering in stables. (In German.) J. Köves and P. Zakar. *Bitumen, Teere, Asphalte, Peche*, 1959, **10**, 393–5.—Experiments are reported on the effects on the appetite, wt increase, and health of 40 kg-wt porkers fed with 10 g extract or dist bitumen produced from Hungarian crude oil for 63–71 days. After the experiments no pathological processes could be detected in the liver and kidneys by histological investigation. With half of the animals fed for 63–71 days daily, each with 10 g lignite pitch, the appetite was impaired, and—compared with the bitumen fed and control pigs—they developed slowly. The other two pigs were not affected notably. In the livers of all four pigs the interlobular connecting tissue increased somewhat, and here and there the liver cell series appeared disarranged. Still, the liver cells, even in these places, were scarcely damaged. From these slight changes it can be concluded that the investigated coal tar pitch contains toxic substances only in small quantity. It was determined that dist and extract mineral oil bitumens in a veterinary-hygienic respect are to be considered as harmless structural materials and, therefore, in opposition to the foreign erroneous statements, can be used for preparing asphalt floor coverings in stables. 16 refs. R. T.

SPECIAL HYDROCARBON PRODUCTS

1184. Gassing properties of aromatic hydrocarbons. W. F. Olds, G. Feick, and E. D. Eich. *National Research Council (U.S.A.)*. Conference on electrical insulation. Publication 842, 1961, 93–8.—Gassing coeff (85° C) on 37 aromatic hydrocarbons (bp 111°–435° C) measured in H_2, using technique previously described (*cf* Abs **1709**, 1960). Reduced gassing coeff (measured gassing coeff/% C_4) shows that results fall into three groups. Benzene derivatives give highest reduced gassing coeff at given vp, naphthalene derivatives lower, and polyphenyl derivatives the lowest values. Effect of temp on gassing coeff is due to vp, not to effect on reaction rate, max occurring at vp of *ca* 1 mm Hg. Activation energy for hydrogenation reaction is hence derived mainly from electrical rather than thermal sources. V. B.

1185. Study of dielectric properties and stability of transformer oil. (In Russian.) Ch. M. Dzuvarly and L. A. Mukharskaya. *Elektrichestvo*, 1961, (3), 83–6.—Quality drop in recent deliveries of transformer oil (high tan δ, low oxidn stability as shown by tan δ/time curves on aging at 105° C) indicates this to be due to trace of Na soaps, removable by H_2O wash. On oxidn there is initial drop of tan δ due to adsorption of oxidn products on colloidal Na soap particles, forming protective sheath round latter. Influence on oil stability of crude choice is marked, also narrow cut (350°–420° C) is more stable than wide (290°–520° C), which latter has been used. Acid/alkali refining treatment for transformer oil could with advantage be replaced by counter-current adsorption refining of dist. V. B.

1186. Insulating oil developments. (In German.) H. Krahmer. *Freiberger Forschungsh.*, 1960, **A164**, 220–5.—Cable impregnant made from 40% viscous extract (to impart low VI) and 60% heavy dewaxed oil from German crude, mixture having d_{50} 0·956, visc° E 26·7/70° C, 5·73/100° C. Refined with 10 vol·% conc H_2SO_4 at 60°–70° C; earth treatment 15% + 10% both at 120° C. Overall yield 40%. Condenser oil made from 28% spindle dist 72% extract, both components

from same German crude. Refined with 10 vol % 96–98% H_2SO_4 > 20°–25° C (cooling required). Neutralized with 10% alc NaOH at 70° C, washed with $MeOH/H_2O$, then H_2O; 15% earth at 110° C. Overall yield 65/70%. All refining operations under N_2. V. B.

COAL, SHALE, AND PEAT

1187. Chemism of coking, investigated on polymeric coal model materials. IV. Pyrolysis of model materials without special functional groups. (In German.) P. M. J. Wolfs, H. I. Waterman, and D. W. van Krevelen. *BrennstChemie*, 1959, **40**, 241–51.—Polymeric model materials formed by condensation of aromatic hydrocarbons and formaldehyde are submitted to pyrolysis. By using radioactive formaldehyde the number of bridges in the original products of each polynuclear aromatic could be determined accurately, so that the structure of the original material could be determined; at the same time it was possible to follow exactly the pyrolysis mechanism by combination of radiochem, thermogravimetric, and elementary analytical methods. In coking these model materials two phases are to be distinguished. Primary coking is a type of depolymerization in which the H_2 is distributed again over the fractions. Fractions to which H_2 is transferred vaporize in the form of tar, the remainder condenses to semicoke. Primary coking is a statistic procedure, which is controlled by deficiency of reactive H_2. During primary coking this H_2 is split off from the aliphatic CH_2 bridges, whilst the aromatic H_2–C-cpds remain intact. The aromatic H_2 is first repelled during the *sec* coking, in which absolutely no tar formation arises. This H_2 split off during the *sec* coking partly forms CH_4, whereby the C, however, is not abstracted especially from the bridge structures, but from the whole C skeleton, if also the C of the original CH_2 groups is preferred to a small degree in this CH_4 formation. 17 refs. R. T.

CORROSION

1188. How zinc fights corrosion. E. W. Horvick. *Industr. Engng Chem.*, Feb 1961, **53** (2), 58A.—In the chemical and allied industries the trend in plant construction is towards using zinc coatings to protect steel structures and other parts against corrosion. Zinc coatings are applied by hot dip galvanizing, electrogalvanizing, metallizing or spraying, sherardizing, and painting. Each method has a specific reason for use, and these are described in the paper. M. F. M.

1189. Bacterial slime and corrosion in petroleum product storage. R. J. de Gray and L. N. Killians. *Industr. Engng Chem.*, Dec 1960, **52** (12), 58A.—A bacterial examination of water–petroleum fraction interfaces has been made as part of a broad study of gasoline sediment and clarity. Samples obtained from such water–petroleum fraction interfaces were shown to contain a variety of bacteria, and these bacteria are indicated in a table. The permanent residents of tanks are predominantly bacillus species. However, all of the flora are normally present in soil and in ground water.

The authors have investigated bacterial growth under conditions similar to that of refinery tanks. It is shown that bacteria accelerate corrosion of iron pipes and tanks and that some rust inhibitors appear to function as nutrients for the bacteria. Not only bacteria encourage rust; rust encourages bacteria, and this is shown by a simple experiment. A bactericide such as a boron cpd will break this vicious circle. The deterioration associated with bacterial contamination of refined petroleum products such as gasoline, kerosine, jet fuel, etc., can be controlled by the use of hydrocarbon-soluble boron cpds. M. F. M.

1190. New method for locating electrical shorts and open couplings. D. D. Byerley. *Petrol. Engr*, March 1961, **33** (3), D24.—This article describes a new method and apparatus for locating underground electrical contacts and open couplings in installing and maintaining cathodic protection systems on coated pipelines. Briefly, the method depends on determining the electrical field around a pipeline along which flows an audio frequency alternating current. Immediately above the pipe a null is formed, and the new method depends on disturbance of the null. The method and apparatus are described in some detail. G. D. F.

1191. Measurement of coating leakage conductance. I. M. E. Parker. *Petrol. Engr*, March 1961, **33** (3), D20.—The electrical conductance of pipe coatings is a very useful quantity in evaluating the effectiveness of such coatings. It gives an indication of coating quality and is nearly proportional to the amount of current required for cathodic protection. The theory behind the measurements is developed, and the scope and limitations of the measurements are discussed. G. D. F.

SAFETY PRECAUTIONS

1192. Economics of a sound safety programme. Pt 3. Establish safety as an independent function. J. H. Herbert. *Oil Gas J.*, 20.2.61, **59** (8), 132–4.—Two moves are suggested for improving injury and fire experiences. These are the establishment of safety as an independent function, reporting directly to the manager or assistant manager, and the utilization of the safety post as a key training point for outstanding men. A. D. S.

1193. Treatment of kerosine poisoning. Anon. *Brit. med. J.*, 1961, **i**, 521, 1056.—Position is controversial, some recommend gastric lavage and others maintain that as kerosine absorption from stomach is not serious, but aspiration pneumonia is, stomach should not be washed out. Refs to paper, and correspondence on controversy. V. B.

1194. Silicones combat foaming in residuum storage tanks. P. M. Waddill *et al.* *Oil Gas J.*, 27.2.61, **59** (9), 85–7.—The destructive $9-million fire at Signal Oil & Gas Co's refinery in California in 1958 was caused by a steam- or water-induced froth wave which foamed over from a vis-breaker feedstock tank and ignited. A stable foam swept across the refinery at an average rate of 400 ft/min.

A study was made of foaming tendency and foam stability and the effect of silicone anti-foam agent. It was shown that 0·2 ppm silicone anti-foam agent in the residuum stocks protected storage tanks from foaming and that this concn did not adversely affect the asphalt properties. Whilst the anti-foam agent may not prevent a residuum tank from foaming over, the spilled oil will have nearly zero foam stability and the tank dyke should contain it. A. D. S.

MISCELLANEOUS

1195. Benzene formation during oil gasification in hydrogen. P. J. Owens, R. Long, and F. H. Garner. *Industr. Engng Chem.*, Jan 1961, **53** (1), 10.—By-product benzene is formed by thermal hydrogenolysis of both paraffinic and *cyclo*paraffinic hydrocarbons. Temp of 500°–800° C, reaction times of 5–40 sec, and a pressure of 10 atm were used for the study of the formation of benzene.

The benzene-forming reactions included dehydrogenation of *cyclo*hexane and methyl*cyclo*hexane, and isomerization, followed by dehydrogenation of methyl*cyclo*pentane. Benzene was also formed from *n*-pentane by a mechanism which is still obscure. The gas-forming reactions in all cases were those expected of thermal cracking in the presence of hydrogen. M. F. M.

1196. A new catalyst for oxidation of propylene with air. J. F. Woodham and C. D. Holland. *Industr. Engng Chem.*, 1960, **52** (12), 985.—Several cat composed of cpds of copper have been studied on a qualitative basis to determine their suitability for catalysing reactions between propylene and air. One particular cat was studied in detail (preparation of this cat is described in the paper) at a pressure of 2 atm and temp around 500° F. With this cat propylene is oxidized primarily to acrolein in yields as high as 45% of the reacted propylene. Acetone and carbon dioxide were also formed as primary products.

A flow type reactor was employed in this work. Recognized analytical procedures were adopted with some modification for the isolation, identification, and quantitative estimation of carbonyl cpds obtained. The product distribution as a function of the operating conditions and the proposed stoichiometry for the reactions are presented in the paper. M. F. M.

1197. Combustion nuclei an index for classifying gaseous hydrocarbon fuels. J. E. Quon, B. D. Tebbens, and J. F. Thomas. *Industr. Engng Chem.*, March 1961, **53** (3), 235.—A method for calibrating a photo-electric nucleus counter, together with its use for the classification of simple hydrocarbon fuels, is presented. A max nucleus-free fuel rate, characteristic of the beginning of carbon formation, was found for each fuel. The reciprocal of this fuel rate was defined arbitrarily as the relative air pollution potential of a fuel. The photo-electric nucleus counter allows the classification of fuels at the inception of carbon formation. This is not possible with conventional smoke point tests. M. F. M.

1198. Applied hydrocarbon thermodynamics. Pt 22. Fugacities for components of vapour mixtures. W. C. Edmister. *Petrol. Refin.*, Oct 1960, **39** (10), 167–72.—Fugacities of components in vapour mixtures are calculated from PVTC data, which may be correlated by graphical or analytical equations. The theory is described for calculating the fugacities from verial equations of state, the Leyden and Berlin equations. M. J. M.

1199. Western dependence on oil. R. J. Sarjant. *Nature, Lond.*, 1961, **189**, 626.—Analysis of the relative importance of coal and oil as fuels in Great Britain. Criticism is made of the National Coal Board's attitude to research and to the utilization of coal products, and it is argued that the challenge from oil can be met by an increase in technological activity.

Oil companies are criticized for fixing the price of oil in W Europe at too low a level, and for an apparent inflexibility in refinery operation. H. C. E.

1200. Australia—best place to have an oil well. J. M. Rayner. *Petrol. Engr*, April 1961, **33** (4), E3.—The great lack of oil in Australia and its effects on the country's economy are outlined. Exploration is actively encouraged by tax remissions, grants, etc., and concessions to some 60 companies covering 3 million sq miles are listed. Nearly 600 wells have been drilled, and there have been some non-commercial discoveries. There is also a map showing the sedimentary basins in Australia and New Guinea. The refining facilities in Australia are outlined. G. D. F.

ADDITIONS TO THE LIBRARY

Entries are in subject order arranged according to the Uren "Classification for Petroleum Bibliography," the number preceding each entry indicating the classification and corresponding to that used in the "Library Catalogue" published by the Institute.

050 INSTITUTE OF PETROLEUM. A glossary of petroleum terms; edited by George Sell. 3rd ed. rev. and enl. London, IP, 1961. 39 p.

081 THOMPSON, A. Beeby-. Oil pioneer ... London, Sidgwick and Jackson, 1961. 544 p.

094 BRITISH STANDARDS INSTITUTION. Specification for density hydrometers and specific gravity hydrometers. London, BSI, 1960. 34 p. (BS 718: 1960.)

094 BRITISH STANDARDS INSTITUTION. Methods for sampling and testing of mineral aggregates sands and fillers. London, BSI, 1960. 84 p. (BS 812 : 1960.)

094 BRITISH STANDARDS INSTITUTION. Specification for tarmacadam "tarpaving" for footpaths, playgrounds and similar works. London, BSI, 1960. 14 p. (BS 1242 : 1960.)

094 BRITISH STANDARDS INSTITUTION. Specification for oil suction and discharge hose. London, BSI, 1960. 27 p. (BS 1435 : 1960.)

094 BRITISH STANDARDS INSTITUTION. Specification for one-mark pipettes. London, BSI, 1961. 12 p. (BS 1583 : 1961.)

094 BRITISH STANDARDS INSTITUTION. Specification for bitumen macadam with crushed rock or slag aggregate. London, BSI, 1961. 24 p. (BS 1621 : 1961.)

094 BRITISH STANDARDS INSTITUTION. Specification for winter gritters for roads. London, BSI, 1960. 19 p. (BS 1622 : 1960.)

094 BRITISH STANDARDS INSTITUTION. Specification for identification of pipelines. London, BSI, 1960. 16 p. (BS 1710 : 1960.)

094 BRITISH STANDARDS INSTITUTION. Specification for one-mark volumetric flasks. London, BSI, 1960. 10 p. (BS 1792 : 1960.)

094 BRITISH STANDARDS INSTITUTION. Recommendations for the use of bitumen emulsion (anionic) for roads. London, BSI, 1960. 21 p. (BS 2542 : 1960.)

094 British Standards Institution. Specification for pressure regulators for use with butane/propane gases. Part 3. Variable high pressure regulators. London, BSI, 1960. 14 p. (BS 3016: Part 3: 1960.)

094 British Standards Institution. Code for the continuous sampling and automatic analysis of flue gases: Indicators and recorders. London, BSI, 1958. 74 p. (BS 3048 : 1958.)

094 British Standards Institution. Rubber reel hose for fire fighting purposes. London, BSI, 1959. 8 p. (BS 3169 : 1959.)

094 British Standards Institution. Specification for road marking materials. Part 2. Hot-applied thermoplastic materials (inset type). London, BSI, 1960. 14 p. (BS 3262: Part 2: 1960.)

094 British Standards Institution. Specification for carbon steel pipe flanges (over 24 inches nominal size) for the petroleum industry. London, BSI, 1960. 19 p. (BS 3293 : 1960.)

094 British Standards Institution. Method for the determination of vapour pressure of liquefied petroleum gases. London, BSI, 1961. 14 p. (BS 3324: 1961.)

094 British Standards Institution. Method for the determination of Reid vapour pressure of petroleum products. London, BSI, 1961. 18 p. (BS 3325: 1961.)

260 American Society for Testing Materials. ASTM Standards on petroleum products and lubricants (with related information). 37th ed. Philadelphia, ASTM, 1960–1961. 2 vols.

520 Katz, Donald L., *and others*. Handbook of natural gas engineering. New York [etc], McGaw-Hill, 1959. 802 p.

520 Lawrie, James. Natural gas and methane sources. London, Chapman and Hall, 1961. 204 p.

614 Tanker Register. The tanker register. London, H. Clarkson and Co., Ltd, 1960. 207 p.

934 Directory of Opportunities for Qualified Men. Directory of opportunities for qualified men, 1961. London, Cornmarket Press Ltd, 1961. 155 p.

935 National Fire Protection Association. The national fire codes, 1960–61. Boston, Mass., NFPA, 1960.

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OILFIELD EXPLORATION AND EXPLOITATION

GEOLOGY

1201. Relations between coal and petroleum. (In German.) H. Jacob. *Erdöl u. Kohle*, 1960, **13**, 5–11.—Vegetable and animal substances form the raw materials for coal and petroleum. These fossil fuels originated under different facial conditions from original substances which show certain differentiations. The result can be that—during the biochemical phase—different substances are produced. On the other hand is to be considered that liq migrated petroleum constitutes only a very small proportion of the org substance of petroleum mother rocks. As with coals, it consists chiefly of highly-condensed epds. Petroleum bitumen—in contrast to coal bitumen—is normally liq, but contains also dissolved solids, which narrows the physical difference. Genetic relationship is supported by the condition that, not perhaps the protobitumens (plant bitumens) of lignite, but much more certain substances, which must have arisen, give extract bitumen. The H/C–O/C-diagram after van Krevelen, by which the approx reaction courses for carbonization, bituminizing, and total oxidn can be followed, gives good service. The material groups of plants and animals are decomp under aerobic conditions chiefly to CO_2 and H_2O. Under anaerobic conditions oxidn products mentioned, and by reduction bitumina or humus substances arise. The former are ± hydrogenated, the latter dehydrogenated. Calculating for coals, petroleums (and asphalts) also for the most important material groups of plants and animals, the H/C and O/C ratio numbers, and entering them in a diagram, characteristic numbers are obtained: carbonization band, bituminizing field, and smaller regions for plant and animal groups. Lignite tends, above all, to humification, whereas albumen under suitable facial conditions probably yields petroleum or asphalt. Extract bitumens of soft lignites lie—according to H/C and O/C—in the bituminizing field. Thus they show closer relationship to asphaltenes than to coal humus. However, polymer bitumen (Kerogen) from petroleum mother rock, by reason of low H/C, must be regarded as a coaly substance. Bituminizing—formation of petroleum and coal bitumen—is produced by alk reaction with the substrate. The Redox potential shows for humus and petroleum mother rock, within the reduction zone, approx the same val. The introductory oxidative material decomp in the oxidn zone is more strongly marked with coals, whereby also considerable differentiations exist. Lithotypes produce the best and most coal bitumen, being exposed to relatively strong oxidn. Consequently—as for petroleum and asphalt formation—also for the origin of coal bitumen, cracking and reduction processes are decisive. 22 refs. R. T.

1202. Underground storage ideal for LPG. G. P. Jennings. *Oil Gas J.*, 1.5.61, **59** (18), 106–10.—Because of relatively low construction cost and safety, underground storage is ideal for LPG and other high vapour pressure products. The types of caverns used are: (1) conventionally mined caverns in impervious rock, *e.g.* shale; (2) solution mined caverns in salt domes; (3) solution mined caverns in bedded salt. Mined caverns are usually 250–400 ft below surface. Compression

of the vapour as liq level rises, generating undesirable heat and pressure, can be avoided by using spray headers for filling, and this practice also prevents stratification. Salt-dome caverns are excavated by drilling a hole to the salt (500–1000 ft depth) and injecting fresh water through the tubing, extracting brine through a protective string. A hydrocarbon blanket is maintained above the bottom of the protective string, and the latter may be raised or lowered to control the shape of the cavern. On completion, LPG is pumped down the tubing, displacing brine to the surface, the reverse procedure being followed for emptying the LPG. Caverns in bedded salt are similar, but have additional problems, owing to interbedded shale breaking away from the walls, sometimes damaging tubing, and ultimately reducing the cavern capacity.

J. C. M. T.

1203. Panhandle gas hunt sets hot pace. Pt 1. B. E. Barby. *Oil Gas J.*, 29.5.61, **59** (22), 210.—Successful drilling in the Panhandle area of Oklahoma has led to the recent discovery of new pay zones and new field extensions. Discovery ratios in this area have exceeded 50%, and producing depths are moderate, from 3000 to 8000 ft. Trends are towards the development of the deeper part of the basin, which has the same pays as along the flanks. Present development and future prospects for gas production in the area are analysed and the regional geology described. The Permian, Pennsylvanian, and Mississippian contain six series of formations of major productive importance: the Wolfcamp, Virgil, Missouri, Des Moines, Morrow, and Chester. There are now *ca* 2600 producing gas wells in the four main counties. C. A. F.

1204. N Texas gets remote oil find. Anon. *Oil Gas J.*, 8.5.61, **59** (19), 138.—1 Sandifor, 20 miles SE of the Raspberry field in Foard County, N Texas, has had commercial oil and gas in the Strawn at *ca* 4300 ft. The find is significant because it occurs in an obscure area of the Red River Uplift which consists of a buried series of scattered granite peaks blanketed by Palæozoic and Cretaceous rocks. C. A. F.

1205. Natural gas recognizes no barriers. Anon. *Oil Gas J.*, 24.4.61, **59** (17), 104–13.—The gas reserves of 147 gas fields from the world's 57 major gas areas and the 90 principal fields of N America are tabulated. The year of discovery, original reserves, cumulative production, number of wells, and the age and depth of the producing formation are also given. Gas is produced from all but Cambrian rocks. Production is *ca* equally divided between sandstone and limestone reservoirs. The Mid Continent province of U.S.A. holds the biggest reserves, with 104·2 trillion cu ft. J. C. M. T.

1206. Search for Red Medina gas sparked by Brooky hit. J. C. Grunau. *Oil Gas J.*, 15.5.61, **59** (20), 218.—There have been recent gas finds in the area of NE Ohio and NW Pennsylvania and one of the most significant is 1 F. W. Brooky in Crawford County, Pennsylvania, which flowed 2·6–6 MMcfd from the Lower Silurian Red Medina sandstone. This wildcat opens a new area to drilling, and there are good prospects for developing further substantial gas production from the region. The Red Medina produces from several fields, such as Monroe, Dorset, and Indian Spring, and it consists of poorly sorted fine to medium grained sandstone with shale laminations. It shows lateral variation and grades to a shaly sand where it is non-productive. It responds well to fracturing. Drilling and completion practice in the area is outlined. C. A. F.

1207. Minnelusa production jumps to north in Powder River. F. J. Gardner. *Oil Gas J.*, 15.5.61, **59** (20), 217.—One of the best unexplored oil prospects in the U.S.A. is the N lobe of the Powder River Basin in Wyoming. This has been emphasized by a recent find in Campbell County, where 1 Government-Gentry found oil in the Pennsylvanian–Minnelusa at *ca* 5400 ft. This is the most N Pennsylvanian discovery in the basin in an area which has been sparsely drilled. There are prospects of multiple pays, many folds and faults in the W, and excellent possibilities for stratigraphic trapping, in spite of the intensive drilling to the S since the end of the 19th century. C. A. F.

1208. Arctic piercement structures. Anon. *World Petrol.*, May 1961, **32** (5), 67.—Aerial photographs have revealed piercement structures which may be salt domes in the Canadian Arctic islands. They occur near the centre of deep Mesozoic basins, and there are large gypsum cores exposed. One of these is the Isachsen dome, approx circular like the Gulf coast domes, but others are elongate. They are potential oil targets and are situated mainly on the 78th parallel on the Ringes islands. Nearest production is the Norman Wells Devonian reef 1000 miles SW. C. A. F.

1209. Bolivian find stirs hopes. Anon. *Oil Gas J.*, 15.5.61, **59** (20), 118.—A Bolivian well, Caranda-3, NW of Santa Cruz, has tested at the rate of 1570 bd of 51° API oil through a ¼-inch choke from a total depth of 3600 ft. The oil sand is believed to be over 100 ft thick, and the well is on a structure 10 miles long. Two earlier near-by wells produced 325 and 400 bd respectively from *ca* 6000 ft. J. C. M. T.

1210. Australian oil find whips up waves of hope. Anon. *Oil Gas J.*, 8.5.61, **59** (19), 78–9.—Cabawin-1, a wildcat W of Brisbane near Tara, Queensland, Australia, has tested 80 bd of 48° API crude and 650,000 cu ft/day gas. Total depth is 12,035 ft, but the oil is thought to come from *ca* 9935 ft. The well is reported to be on the flank of a large structure.

J. C. M. T.

GEOPHYSICS AND GEOCHEMICAL PROSPECTING

1211. New tools for the geophysicist. Anon. *World Petrol.*, March 1961, **32** (3), 49.—One of the main features of geophysical developments in 1960 was the further development of miniaturizing field equipment. Modern analytical and statistical procedures continue to be applied to processing and analysis of field records, and office equipment is being refined to eliminate resonance and uncalibrated time differences. There is much effort in improving methods for locating stratigraphic traps.

Seismic and geological data are being reduced to digital form for high-speed evaluation; cores, for example, are being analysed by X-ray spectrograph and grain shape classifiers, and 200 samples/day can be analysed. C. A. F.

1212. Old gravity should never die. J. L. Bible. *World Petrol.*, March 1961, **32** (3), 48.—As seismic data are interpreted directly in terms of subsurface information and usually transferred to geological maps they are readily available. Old gravity data, however, tend to be overlooked in modern interpretations, and it is emphasized that the interpretation of old gravity records by using modern techniques can reveal valuable subsurface information. This is possible in spite of the lower accuracy of older gravity meters, because some of the older surveys were carried out in detail for some areas which at the present time cannot be surveyed because of lack of permits or excessive costs. In many areas several residual and differential residual gravity maps are useful in analysing several zones of interest. In the Gulf Coast a residual map can show very accurately the cap rock on piercement domes.

C. A. F.

1213. French seismograph developments. Anon. *World Petrol.*, March 1961, **32** (3), 60.—Three recent developments in French seismic tools are described: (1) the transistorized seismograph recording system AS 604R; (2) a magnetic tape transcribing system; and (3) a millisecond delay line. The

transistorizing system provides re-record facilities for most types of magnetic field recording systems and traces are transcribed sequentially in groups of four channels for the "Magnedisc" system and in a single trace for all SIE systems. The transistorized delay line is used for time corrections, filtering, removal of singing in marine areas, and high line on land.
C. A. F.

1214. Radioactivity surveying. W. D. Crews. *Oil Gas J.*, 8.5.61, **59** (19), 132.—It has been known for many years that there is a relationship between surface variations in radioactivity and the presence of oil at depth, but only recently has radioactivity surveying been scientifically adapted to oil exploration, and the method has proved successful in some areas. Any successful use of the method requires an understanding of the origin of the radioactive anomalies, and the latest theory supposes that there is a series of radioactive inducements and subsequent re-emissions originating at depth and eventually reaching the surface. This "photodisintegration" requires the ordered subsurface distribution of radioactive particles, and the accumulation must act as an energy transfer medium (or absorber) for γ-radiation which encounters it. Methods of measuring anomalies are outlined, and examples of radioactivity maps and surveys are included. The technique has been controversial for many years, and it is shown that it is only a valid method if proper instrumentation is used.
C. A. F.

1215. New instrument eases survey work. Anon. *Oil Gas J.*, 8.5.61, **59** (19), 139.—The Tellurometer, which has been developed for surveying, is briefly described. It resembles and operates like radar by sending out microwaves and recording the elapsed time for the signal to return. It has recently been used successfully in Montana, where heavy forest made distance measurements in seismic work a problem. In one series of lines the method was in error by only 0·47 ft in *ca* 45 miles. The tool cut surveying time by half. C. A. F.

1216. Weight dropping in N Africa. A. D. Waldie. *World Petrol.*, April 1961, **32** (4), 47.—Over two dozen crews are now operating the weight dropping technique for seismic work in various parts of the world. The method has been especially useful in N Africa, particularly Libya. The need for explosives, drilling, water trucks, and other associated equipment is eliminated, the shock wave being produced by the drop from a truck of a large mass. This weighs *ca* 6000 lb, and the drop is comparable to a 2½ lb 60% gelatine dynamite blast. The wt is readily portable, and it has enabled good records to be obtained in areas of poor conventional record quality. It also obtains consistently better results at a lower cost in areas of good seismic record quality. Over 28,000 drops/working day can be made. C. A. F.

1217. New oil-hunting tool will get commercial tryout in Libya. Anon. *Oil Gas International*, May 1961, **1** (5), 39.—A new geophysical tool, the Vibroseis, is to be tried out in Libya. It is a surface vibrator system which generates seismic waves. The vibrator is mounted on a truck, and this emits waves at frequencies determined by signals received by radio from a control truck. The tool will reduce costs, as there are no shot holes, and better speed, controls, and data should enable recorded signals to be correlated with introduced signals with the min effect of stray noise.

An operator at the control truck broadcasts signals from magnetic tape at pre-determined frequencies, and the waves generated by the vibrator are picked up by geophones.
C. A. F.

DRILLING

1218. Five ways to reduce drilling costs. R. L. Parker. *World Oil*, May 1961, **152** (6), 82.—The increasing cost of finding oil in the U.S.A. has encouraged intensive efforts to reduce well costs. If market prices of products could be raised there would be no problem, but as this is not possible under current economic conditions, there is active research into reducing drilling costs by using new techniques and policies. This can be achieved by concentrating on five aspects of drilling: operational policies, contractors' policies, drilling contracts, drilling equipment, and well programmes. Each of these is briefly discussed. C. A. F.

1219. New dual-weight drill pipe turns in good performance. *Oil Gas J.*, 1.5.61, **59** (18), 98–9.—Damage often occurs to lightweight pipe close to the joints when setting slips. A new type of pipe has thin wall section over most of its length, but the last 4–6 ft at the box end is thicker, and damage is avoided. Compared with standard wt pipe, depth capacity of drilling rigs is increased by *ca* 15% if the dual wt pipe is used.
J. C. M. T.

1220. How air and gas drilling cut costs at two foothills wells. Anon. *World Petrol.*, May 1961, **32** (5), 68.—Air and gas have been successfully used as drilling media in two wells recently completed in the foothills of Alberta. There was less hole trouble, higher bit penetration rates, and lower bit charges, which gave significantly lower drilling costs. Full details of drilling procedures are given, and main equipment, apart from conventional tools, consisted of Blooey line, rotating blowout preventer, bug fans for derrick floor and collar, meter loop, and a standby compressor to increase gas pressures up to 2500 psi for abnormal conditions. Drilling cost reductions in W Canada are of prime importance, and substantially cheaper drilling could be an effective incentive to increase exploration and drilling in the region; this may be achieved by proper application of air and gas drilling. C. A. F.

1221. Tungsten carbide inserts slash reamer costs in hard-rock drilling. E. McGhee. *Oil Gas J.*, 24.4.61, **59** (17), 160–2.—New insert-type tungsten carbide reamers have proved to be superior to carbide surfaced or milled-tooth reamers in abrasive formations in Texas and New Mexico. The tungsten-carbide inserts are mounted in axially disposed rollers and spaced so that no more than three on each roller are in contact with the hole wall simultaneously. The combination of true rolling action and low bearing load results in long bearing life. Rock is removed by crushing, flaking, and chipping.
J. C. M. T.

1222. Get full life from your rigs' wire line. R. G. Dull. *Oil Gas J.*, 22.5.61, **59** (21), 74–7.—The object of a wire-line cut-off procedure is to move the line through the system at a rate which allows the rope to be removed before failure and distributes wear evenly. Two areas of particular wear are points of drum cross-over and the places where the rope is in contact with the travelling and crown block sheaves when removing the slips. Tables have been prepared using an IBM computer to enable round trip ton-miles to be determined for the many different operations and wt of equipment used in drilling. In conjunction with another table giving the correct cut-off length according to rig dimensions, the optimum times at which to cut can be obtained. J. C. M. T.

1223. Continuous-core drilling rig. H. I. Henderson. *Oil Gas J.*, 8.5.61, **59** (19), 96–100.—A pilot-model continuous core drilling rig has completed a year of successful service. The drill pipe has two concentric layers. Mud is pumped down the annular space between these. The annulus between the outer pipe and the hole is normally filled with static mud. Cuttings and 6-inch lengths of core are carried by returning mud up the central bore to the surface. An electric power swivel is used to rotate the pipe. Power requirements for this and for pumping are abnormally low. Core recovery in hard formations is virtually 100%, and cores are obtained from friable

sands and soft sandy clays which would usually be considered un-corable. Drilling rate is comparable with conventional core drilling. Costs fall between those of conventional core drilling and ordinary drilling. An unexpected benefit is that there is little hole caving or sloughing. J. C. M. T.

1224. Geothermal gradients now known in greater detail. P. L. Moses. *World Oil*, May 1961, **152** (6), 79.—A knowledge of subsurface temp has become more important recently with the development of deeper drilling, and results of borehole temp surveys in Texas and Louisiana are presented as a contour map showing variations in geothermal gradients for the region. In most cases subsurface temp were found to show an approx linear increase with depth, and a straight line assumption was used in preparing the geothermal map. A detailed tabulation also gives reservoir temp at specified depths for many fields in the U.S.A. and Canada, listed by states. Six refs. C. A. F.

1225. Modern well completion series. Pt 12A. Oil well cementing practices and materials. P. C. Montgomery and D. K. Smith. *Petrol. Engr*, May 1961, **33** (5), B91.—An extensive compilation of information on cementing operations is presented. The history of such operations is outlined briefly, together with information on contemporary practice. The planning of a cement job is considered, including the equipment and accessories required. Finally, the various types of cementing jobs are described in some detail. G. D. F.

1226. Dynamic stresses in long drill pipe strings. T. Vreeland Jr. *Petrol. Engr*, May 1961, **33** (5), B58.—When slips are set on a moving drill pipe, dynamic stresses are added to other stresses present. The paper considers the manner in which the stresses are propagated, the travel of return stress waves, the effect of tool joints, the load on slips, and methods of reducing dynamic stresses. It is considered that shock-absorbing devices can hardly be justified. G. D. F.

1227. Rheology of colloidal suspensions, especially of drilling muds. (In German.) K.-H. Grodde. *Erdöl u. Kohle*, 1960, **13**, 11–18, 79–83.—Pt I. Friction laws, flow properties, and flow behaviour. Pt II. Application to drilling practice. Extension of the known laws for laminar flow of plastic and structurally-viscous media through tubes, to thixotropic-plastic materials, is considered. This is valid, especially for the derivation of the analogous laws for flow through the annular space of concentric tubes as well as the simple rheonomic systems, also through the annular space of eccentric tubes, which, in general, was investigated for the first time. The crit rate for non-Newtonian liq was clarified successfully, and other authors and own data checked. Experimental investigation of pressure losses in turbulent flow of plastic and structurally-viscous media yielded astonishing results for the latter. Pressure losses in turbulent flow, in so far as accurate measurements were available, showed a simple conformity to law. Eqn now presented permit rapid determination of flow-pressure of drilling muds with practically sufficient accuracy which was absent previously on account of falsely-used laws, Pt II. Pressure fluctuations with drill stem movements and tube installation in conformity to law are considered with relevant examples. A complete and extensive experimental and mathematical treatment of the fall rate of drilling fines in circulation, or generally of bodies of random form and size in plastic and/or structurally-viscous media, led to formulation of two gravity laws, namely, for laminar and for semi-turbulent fall, which present an extension of the Stokes gravity law in many aspects, and are used universally. Since the relations between flow properties and compositions of colloidal suspensions are known roughly, regulating optimum flow properties on the basis of the explanations presented is possible now for each case arising practically in drilling technique. R. T.

PRODUCTION

1228. Controlled filtration rate improves cement squeezing. H. J. Beach *et al.* *World Oil*, May 1961, **152** (6), 87.—Successful squeeze cementing requires placing cement seals to prevent fluid flow into or out of the treated interval. Tests in the Wadsworth field of Texas have shown that low-filtration rate slurries are needed for preventing choking of casing and isolation of perforations during squeezing. Squeeze pressures should be high enough to force cement into perforations filled with mud cake, but not into clean perforations. The amount of cement required to seal perforations and voids behind casing is usually small, and the aim is to build filter cake with a small vol of slurry, rather than force large vol into pressure-formed fractures. Controlled filtration rates have been carried out in field trials, and details of slurry characteristics are given. Over 100 treatments have now been evaluated, and it is shown that overall success is higher than for conventional squeezing. Eight refs. C. A. F.

1229. Differential liberation increases liquid recovery. J. A. Perkins, Jr. *Petrol. Engr*, May 1961, **33** (5), B26.—An alternative to the flash method of separating dissolved gas from a hydrocarbon liq is presented. The differential process is carried out in such a way as to maintain throughout the fall in pressure a continuous change in the compositions of the gas and liq phases. Tests show that 10–15% more liq can be recovered and saved by the use of this method. Field application and design of the equipment is dealt with. G. D. F.

1230. Stop pounding that pumping well. J. S. Martin. *Petrol. Engr*, May 1961, **33** (5), B66.—The paper considers the detrimental effects of "pounding" on the sucker rod, the pumping unit, the prime mover, and the gear reducer. Pounding often sets in when attempts are made to pump liq from a well faster than it flows into the bore. Methods of avoiding fluid pound are considered. G. D. F.

OILFIELD DEVELOPMENT

1231. Disturbed belt search revives. J. C. McCaslin. *Oil Gas J.*, 22.5.61, **59** (21), 121.—There is revived interest in the oil prospects of the Disturbed Belt of Montana, where intermittent wildcatting has occurred since 1955. Four wells were drilled in 1960, but only one showed indications of commercial production. It is difficult to explain these failures because of the important gas potential of this same belt to the N in Alberta, where such fields as Pincher Creek and Turner Valley have been developed. C. A. F.

1232. Canada's exploration—1960. Anon. *World Petrol.*, May 1961, **32** (5), 52.—Exploration and development drilling in E and W Canada in 1960 are reviewed. There has been an overall decline in W Canada, but further fields have been found, including the first gas find in the NW Territories and important gas finds in the Rocky Mountains foothills and NE British Columbia. In E Canada development drilling increased over 1959, but exploration decreased slightly. Four significant finds were reported from SW Ontario. There was much less drilling in Quebec, with slackening in the Maritimes.

Tables show completion and exploratory drilling and field discoveries in Canada for 1960. C. A. F.

1233. Natural gas dominant factor in Canada's petroleum future. L. O. Rowland. *World Petrol.*, May 1961, **32** (5), 45.—There is a large market for Canada's natural gas in California and the Pacific NW states of the U.S.A. It is planned to export gas through a pipeline from Alberta to the San Francisco area, and the initial vol will be greater than the 1959 total of Canadian gas exports. A smaller but fast growing market is developing in the N Central states. The U.S.A.

market will provide a very important revenue source for Canada, tending to offset the chronic market shortage for oil. Recent natural gas developments in Canada are outlined. C. A. F.

1234. Canada's 1960—the year of gas. E. C. Sievwright. *World Petrol.*, May 1961, **32** (5), 41.—Crude production in Canada in 1960 increased by 7·9% and natural gas sales by 14·6%. Permission has now been granted for export of gas to the U.S.A., and a new decision has been taken to give refiners in E Canada three years to alleviate the market shortage for potential oil production in W Canada. Drilling activity in W Canada in 1960 continued to decline, and 2460 wells were completed, 2·2% less than in 1959. Since 1956 there has been a steady decrease in activity in the W, and with the decline in production the commercial development of the major reserves of Athabaska has been deferred until 1965 at the earliest. Supply and demand in Canada are analysed, together with refining data. C. A. F.

1235. Rigs will be busy in Alaska this summer. F. J. Gardner. *Oil Gas J.*, 29.5.61, **59** (22), 209.—Several wildcats are being drilled in Alaska and the Swanson–River–Soldotna area is being developed rapidly. Three–four fields have now been found on the Kenai peninsula, and a new gas field is reported from Falls Creek on the E side of the Cook Inlet. Most of this activity is along the S coast of Alaska, and many companies are involved. A map shows fields and drilling in the state. C. A. F.

1236. How much oil in sight? Eastern Hemisphere's swelling tide of new crude production. Anon. *Oil Gas International*, May 1961, **1** (5), 56.—A survey of oil and gas demand has shown that a total of *ca* 70 million tons of crude oil from new sources will be looking for markets in the next four to five years. To date the main import is from Saharan crude in the French market, which led to a cut in French imports of 3·5 million tons in 1960, but substantial new crude production will be developed from other new areas, such as Libya, Nigeria, offshore areas in the Persian Gulf, and expansion of production from well-established fields, such as those in Saudi Arabia, Iraq, and Kuwait. C. A. F.

1237. Problems in Libya. Anon. *World Petrol.*, April 1961, **32** (4), 44.—Although first applications for surrendered acreage in Libya have been accepted, grants will not be made for some time, and oil development has been retarded by customs difficulties. No new fields were found in the first two months of 1961, but the country has an assured future as a major oil exporter. It is expected that production will average a min of over 1 million bd by the end of 1965. By Feb 1961 it had reached a potential of 126,655 bd, but there will be no production until pipelines to the Mediterranean are completed. Over 70 producing wells have been drilled, the largest being Esso's Zelten at 17,000 bd. Finds have been concentrated in a small area of the Sirte Basin, and the Palæozoic area may not be as prolific as expected. *Ca* 19 companies are operating, and at the beginning of 1961 proved recoverable reserves were estimated at *ca* 2 billion brl. C. A. F.

1238. Pack-off assembly cuts gas-lift installation costs. K. E. Brown, R. W. Donaldson, and C. Canalizo. *Petrol. Engr*, May 1961, **33** (5), B42.—It is shown that frequently the cost of pulling and re-running tubing is the most expensive item in the installation of gas-lift equipment. A pack-off gas-lift assembly is described which can be installed or removed by wire-line units. The installation procedure, production to be expected, cost of installation, and flowing gradient curves are discussed. Other applications of the pack-off assembly are described, *e.g.* unloading water from gas wells. G. D. F.

TRANSPORT AND STORAGE

1239. Natural gas storage capacity up 5·7%. R. Bizal. *Oil Gas J.*, 8.5.61, **59** (19), 83–9.—This annual survey of 59 companies indicates that total reservoir capacity will climb to 3·198 trillion cu ft when projects now under way, testing, or planned are completed. This is a gain of 5·7% over the previous year, but falls short of the average of 13·6% for the 1955–60 period. In Canada the picture is different—of the 16 facilities reported *ca* half are under way or planned. Tabulated details are given of underground storage capacity in the U.S.A. and Canada by state. A. D. S.

1240. Underground storage ideal for LPG. G. P. Jennings. *Oil Gas J.*, 1.5.61, **59** (18), 106–10.—The conclusions of more than 50 operators of underground storage in mined, salt-dome, and salt-bed caverns are presented. Comparisons cover safety, pumping costs, and losses.

Operating problems and costs incurred in mined and salt-dome caverns appear to be very nominal. This is particularly true when the large storage vol they usually provide are considered. In some cases operating costs and problems are greater than those found in pressure storage. Salt-bed caverns frequently present some costly operating problems, but in most cases the high operating costs can be justified by the low initial costs. A. D. S.

1241. Five ways to recover stored LPG from salt caverns without enlarging the cavern. C. T. Brandt. *Oil Gas J.*, 10.4.61, **59** (15), 117–20.—A recent survey shows that 50 million brl of LPG storage capacity has either been completed or is under development in salt caverns in the U.S.A. Currently the most pressing problem is how to recover the product without enlarging the cavern excessively, as occurs when fresh water displacement methods are used. The best known ways—brine displacement, pumping, vaporization lift, and gas displacement—are critically discussed, and it is concluded that each case must be analysed individually to find which method is the most advantageous and economical. A. D. S.

1242. Trends in oil tanker design. J. W. Ross. *Petroleum, Lond.*, 1961, **24**, 169.—It is shown that tanker sizes have been increasing, and two 130,000-ton tankers are reported to be on order. The reasons for this change in size are discussed, and it is pointed out that, for normal use, sizes well below 100,000 tons are still favoured. Recent changes in the structural specifications have led to wt savings. Problems of cargo handling, valves, deck machinery, and amenities are discussed. The use of various plastics and their advantages and disadvantages are mentioned. Finally, the possibility of using submarine tankers is considered. G. D. F.

1243. Tanker availability and requirements: their effects on the tanker market. W. L. Newton. *Petroleum, Lond.*, 1961, **24**, 173.—The world tanker fleet has grown from 16·6 million dw tons in 1938 to over 64 million dw tons in 1960. In the same time the carrying capacity has increased by over five times, due to greater speeds, shorter turn-round times, etc. The tanker demand over the same period is examined in some detail, and there is shown to be a surplus of tanker carrying capacity at present. Future trends in tanker sizes are discussed. Finally, the effect of all these factors on the tanker market is outlined and the outlook is discussed. G. D. F.

1244. Effect of tank coating on tanker efficiency. L. H. Bridges. *Petroleum, Lond.*, 1961, **24**, 178.—The cost of tanker corrosion is discussed, as are the types and causes of corrosion

in tankers handling crudes and various products. Methods of protection are outlined—cathodic protection, chemical additives, etc., but most of the paper is concerned with surface coatings. Various coatings are mentioned, together with their service life, maintenance, etc. G. D. F.

1245. Longer tank life through better design. C. K. Aldrich. *Petroleum, Lond.*, 1961, **24**, 190.—Various problems arising in tank design are discussed, including external corrosion and painting, especially of tank bottoms, interior corrosion, stress-corrosion cracking in various alloys, dissimilar-metal problems, and problems arising in vapour spaces. G. D. F.

1246. Recognizing and evaluating stock tank vapour recovery applications. R. E. Weldon. *World Oil*, May 1961, **152** (6), 75.—The loss of vapour from storage has been combated in recent years by using vapour-tight storage tanks, conservation valves, and more efficient separation. Nevertheless, it is estimated that gas lost annually in the U.S.A. in this way is worth *ca* $35 million. Vapour recovery from lease storage tanks can offset this, and this has been carried out in a refinery in California where operations are described. In planning such a scheme the economics of the project, such as equipment costs, markets for low pressure gas, and its value have to be fully considered. C. A. F.

1247. Could you recover stock tank vapours at a profit? R. E. Weldon, Jr. *Petrol. Engr*, May 1961, **33** (5), B29.—The paper discusses the economics of recovery of stock tank vapours. Three recently installed vapour recovery facilities in the U.S.A. are mentioned. The points to look for in recognizing potential applications and the method of evaluating specific cases are outlined. G. D. F.

1248. New cleaning method avoids damage to internal coating. D. C. Palm. *Petrol. Engr*, May 1961, **33** (5), D26.—A method is described for cleaning the inside of coated pipelines. Briefly, a wheel-suspended "pig" equipped with rotating, spring-loaded nylon brushes is passed along the pipe. G. D. F.

1249. Pipeline research reaches milestone. F. H. Love. *Petrol. Engr*, May 1961, **33** (5), D36.—Certain recommendations on the manufacture, testing, and inspection of lines for the transmission of natural gas resulting from the eight-year research programme of the American Gas Association at the Batelle Inst are outlined. Various investigations on line pipe, secondary stresses, girth welding practices, and branch connexion reinforcements are among those reported on. G. D. F.

1250. Oil pipelines defy normal transport rules. M. E. Hubbard. *Oil Gas International*, May 1961, **1** (5), 48.—It is shown that pipelines follow different economic laws from other forms of oil transport, *e.g.* the larger the capacity of the pipe, the lower the unit cost, but the cost is hardly affected by distance. Main forms of transport are discussed with charts to show comparisons between each, but because of the fundamental difference between pipelines and other means it is difficult to make general comparisons. Pipeline costs vary with circumstances mainly outside the engineer's control. Pipelines appear to be cheaper than rail for amounts of 500,000 tons pa or more, and cheaper than major river transport for amounts exceeding *ca* 1 million tons pa. C. A. F.

1251. Automatic pipeline welding is fast becoming a "must." R. S. Ryan. *Oil Gas J.*, 10.4.61, **59** (15), 122–7.—With the trend to higher strength steels, there is an increasing necessity to develop automatic welding equipment, because the max physical properties of the present manual arc-welding electrodes have been reached. There are two relatively new pieces of equipment for automatic submerged arc welding which are being used for double jointing, and these are described. One of the important advantages of these processes is the ease and extent with which the equipment can be controlled. Consistently good welds are made on joints of wide variations in dimensions.

The most recent developments in automatic equipment are briefly reviewed, including one in which the complete weld is accomplished in a single pass with the consumable electrode shielded by CO_2. A. D. S.

1252. The economics of pipelines. Anon. *Petrol. Times*, 21.4.61, **65**, 277–8.—Three papers, presented at the Pipelines Industries Guild Symposium, are summarized.

The first paper dealt with pipelines in relation to other forms of transport and the author showed, by cost comparisons with road, rail, and river transport, that given a sufficiently large throughput, transport by pipeline was more economic. Tankers, however, were almost always cheaper than pipelines.

The second paper covered the economic design of pipelines for the transportation of liq. The cost of transportation over a period is the sum of the initial materials and installation and the recurrent operating costs. The various factors, some often overlooked, which must be taken into account when considering operating costs, are listed. It is also important to accurately determine the service period when evaluating the cost.

The third paper dealt with gas storage and grid control problems, and considered, amongst other matters, the feasibility of using pipelines for storage of gas under pressure during off-peak periods. A. D. S.

1253. Look what's happened in push-button pipelining in just five years. F. S. Jones. *Oil Gas J.*, 1.5.61, **59** (8), 116–24.—Techniques of pipeline operation have changed rapidly during the past five years. In 1956 very few companies were using automation for unattended operational control pumping stations. In 1960 remote and automatic control had advanced to 37%, unattended operation to 22%, and partially attended operation to 21%. It is forecast that the industry is now entering a period of accelerated evolution. The following changes are discussed—remote switching, hydraulic control, and automatic, shielded arc, and induction welding. A. D. S.

1254. Dynamic programming is proving effective as a means of optimizing power on crude oil pipelines. J. T. Jefferson. *Oil Gas J.*, 8.5.61, **59** (19), 102–7.—Linear and non-linear programming have been extensively applied to the problem of process optimization. After examination of several such techniques, a multi-stage allocation procedure was decided on for optimizing power on crude pipelines. This procedure is applicable to processes which may be broken up into sequential steps, such that the input to each stage consists entirely of the output of the previous stage. The min total pressure of all stations to maintain desired throughput then determines optimum values of pressure for each station.

The development of an analytical statement of the pump-combination selection problem is detailed, and is followed by a brief outline of the multi-stage allocation process. A. D. S.

REFINERY OPERATIONS

REFINERIES AND AUXILIARY REFINERY PLANT

1255. Recent metallic packings and their application. (In German.) R. Braun. *Chem. Ing. Tech.*, 1961, **33**, 350–2.—A new packing material, known as Perfo-rings, is described. The pressure drop and separating efficiency of Perfo-rings are compared with those of Raschig-rings and Pall-rings. A worked example shows the utility of the new packing material. G. D. F.

1256. Heat and flow investigations on finned tube bundles subject to transverse flow. 1. (In German.) H. Brauer. *Chem. Ing. Tech.*, 1961, **33**, 327–35.—This part first reviews the experimental equipment used and gives details of the smooth and finned tubes, the arrangement of the tube bundles, etc. Experiments have been carried out at pressures up to 11 atm. The results are presented in dimensionless form. One result of the measurements is the extension of the range of application of known equations of heat transfers to bundles of unfinned tubes as far as a Reynolds number of 150,000. G. D. F.

DISTILLATION

1257. Direct-contact trays for the contacting of liquids with gases or vapours. (In Russian.) Yu. I. Dytnevskii and A. G. Kasatkin. *Khim. Prom.*, May 1961, 354–6.—A type of contacting tray consisting of parallel overlapping louvres placed at a small angle (*ca* 9° to the horizontal) is described. Investigations are reported on the effect of gas and liq rates on the NTU and the pressure drop of the plate. The results are presented graphically. G. D. F.

1258. On the design of columns for the rectification of binary mixtures under vacuum. (In Russian.) V. R. Ruchinskii. *Khim. Prom.*, May 1961, 344–7.—The paper presents methods for selecting and designing vacuum dist columns, including considerations of efficiency and pressure drop. An exact method for calculating the number of transfer units is presented, as well as a more approx but considerably simpler method. An empirical relation is presented relating the number of transfer units and the pressure for a number of binary mixtures, namely,

$$m = m^\circ + \beta(P - P_\circ)$$

where m, m° are the number of transfer units necessary at pressures P, $P_\circ$ respectively (m° at $P_\circ$ being known) and β is a const. G. D. F.

1259. Distillation in view of modern developments. Pt 2, Chap 2f. Theory of fractionation—multi-component distillation. K. F. Gordon and J. A. Davies. *Petrol. Engr*, May 1961, **33** (5), C37.—It is shown that there are a number of families of methods for calculating multi-component dist, which are: (1) plate to plate; (2) solution of a large number of simultaneous equations; (3) transient approach to steady state or relaxation; (4) graphical; (5) short-cut; (6) empirical. After considering the preliminary steps, these various design methods are dealt with in some detail. Finally, the calculation of absorption and stripping columns is dealt with. G. D. F.

SOLVENT EXTRACTION AND DEWAXING

1260. Rotating disk contactors perform well in propane deasphalting of lube oil. V. B. Thegze *et al.* *Oil Gas J.*, 8.5.61, **59** (19), 90–4.—Rotating disk contactors (RDC) have proved to be superior to conventional extraction columns for several liq–liq extraction systems. Results from several plant runs show that RDC has good flexibility, excellent separating power, and good capacity characteristics in deasphalting operations. The max throughput achieved at 35 rev/min in the plant tower is at least as high as that obtained with conventional towers. The good quality and yield of the deasphalted oils have resulted in a number of simplifications and operating economies throughout the lub oil plant. Variable rotor speed gives improved flexibility in the operation.

Details of the tower, and the effect of rotor speed and temp on asphalt yields and properties are given. A. D. S.

CRACKING

1261. Thermal cracking of crude oil. (In German.) J. Wengler and H. Zeininger. *Chem. Ing. Tech.*, 1961, **33**, 301–11.—Lab experiments are reported on the thermal cracking of three different crude oils and two light benzenes. The effects of cracking temp, residence time, the quantity of superheated steam added, and the coke packing of the reaction tube were investigated. The ethylene yield could be increased by shortening the residence time and increasing the steam ratio, while the propylene yield was scarcely affected by these factors. Fair agreement was obtained with plant-scale data. The displacement from the equilibrium $C_2H_6 \rightleftharpoons C_2H_4 + H_2$ was shown to be particularly large under conditions for optimum ethylene yield. There are very numerous tables and graphs of results, which are discussed exhaustively. 62 refs. G. D. F.

1262. Saharan crude poses problems for French cat reformers. J. E. Henny. *Oil Gas International*, May 1961, **1** (5), 53.—Most Saharan crudes are low in sulphur and, except for Zarzaitine, are richer in naphthas than the Middle East crudes which have been refined in France in the past. To meet current percentage of gasoline requirements it will mean producing excess light naphthas and excess 155–180 heavy naphthas. C. A. F.

1263. Catalytic reforming. F. G. Ciapetta. *Petrol. Engr*, May 1961, **33** (5), C19.—There is a brief review of cat petroleum refining processes, followed by a considerable section dealing with the development of naphtha reforming cat. Platinum and other reforming cat are mentioned. Commercial cat and process variables are discussed, including cat composition and life, effects of the naphtha composition, cat poisons, temp, pressure, etc., and the effect of pretreatment of reformer feeds. There is an extensive bibliography of 88 refs. G. D. F.

SPECIAL PROCESSES

1264. Shell plant augments gas production for the South East. Anon. *Times Rev. Ind.*, 1961, **15** (173), 89–90.—Initially four Segas units, cyclic (210–240 sec) process (timing (%): gas make 48·5–51, blowing 38·5–40·5, purge *ca* 8, valve operation *ca* 2). Cat is lime-impregnated MgO, unaffected by S. Feedstock can vary from gas to 900 sec fuel. 1959 feed was (%) gas 33, light dist 44, heavy fuel 21. Each unit has capacity from 4 m ft³/day (heavy fuel feed) to 5½ (gas feed). Expanded by erection of four Shell non-cat partial oxidn units (total 24 m ft³/day) producing nearly pure H_2; feed varies from CH_4 to 3000 sec fuel. Final total output is 45 m ft³/day four-component computer-calculated blend (typical composition (%) Segas 36, H_2 40, refinery gas 12, N_2 12) of 500 Btu/ft³ and with $<5\%$ CO and $<0{\cdot}01\%$ org S. Expansion to 74 m ft³/day planned. Flow diag. V. B.

1265. The purification of hydrocarbon gases from sulphur compounds. (In Russian.) E. G. Rozantsev and I. I. Berger. *Khim. Prom.*, May 1961, 339–40.—It is shown that the normal caustic purification processes are useful only for the removal of

H_2S and mercaptans, but not other sulphur cpds. Various additives to the caustic soln may improve the efficiency. Cat processes are also useful. The purification of the ethylene and propylene fractions is particularly difficult. For this case, the authors propose the use of a magnesium oxide chemisorbent, the reactions for which are outlined, as are the regeneration reactions. Lab tests have been carried out on the removal of SO_2 from ethylene using the new chemisorbent (MgO on alumina) at 250°–300° C and atm or elevated pressures. The material is easily regenerated by the use of air or steam at high temp. It is concluded that the new method is satisfactory for the removal of sulphur cpds from industrial gases. G. D. F.

METERING AND CONTROL

1266. Union Oil's new electronic gasoline and mid-barrel blender has been exceeding all expectations. A. F. Stribley, Jr, M. W. Adcock, and J. F. Hannaman. *Oil Gas J.*, 1.5.61, **59** (8), 86–93.—An electronically controlled in-line blending system for gasoline and dist fuels has been operating successfully at Union Oil Co's Los Angeles refinery. This facility takes suction from stock tanks as much as a mile away. Gasoline stocks are transferred in a single header and mid-brl stocks are blended and transferred in a separate header. Several million brl of motor gasoline, aviation gasoline, and JP-4 fuel have been blended, and production has been on-grade in all cases.

Details of design and operation are given, together with TEL, dye, and additive handling. A. D. S.

1267. Computer controls the reflux rate on orthoxylene tower. H. C. Bozeman. *Oil Gas J.*, 8.5.61, **59** (19), 110–11.—An analogue computer exercises closed-loop computer control of internal reflux in the orthoxylene tower at Delhi-Taylor Oil Corpn's, Corpus Christi, Texas refinery. Operators use a chromatograph to monitor product qualities, an analysis requiring *ca* 15 min. The unit separates 36 million lb pa of orthoxylene from a mixed-feed system. Separation is done in a 260-ft tower built for convenience in two 130-ft sections. A. D. S.

1268. Instrumentation, controls, and automation. 6. Telemetering. M. T. Nigh. *Petrol. Engr*, May 1961, **33** (5), D31.—This part considers the actual arrangement of messages transmitted in telemetering systems. Systems using both marks and spaces for information are dealt with. Actual examples are given. G. D. F.

PRODUCTS

CHEMISTRY AND PHYSICS

1269. Breakers for crude petroleum emulsions. (In German.) W. Franke. *Erdöl u. Kohle*, 1960, **13**, 18–22.—Development of emulsion breakers for crude oil emulsions from 1936 in Europe and America is discussed. First, crude oil emulsions continually have the character of water-in-oil emulsions and, along with non-ionogenic, only a few anion-active chemicals formerly were effective. Sulphonated and oxethylated castor oil—the first emulsion breakers used in Europe—provided both types of surface-active products, ionogenic-to-ionactive, and non-ionogenic; the structural principle holds good today. Breakers H_2O-insol, oil-sol are rendered H_2O-sol by attaching rests or chains of sulphoacids, which generally are converted to Na-salt, and ethylene oxide. Statistics show that not all similarly constructed org products are suitable emulsion breakers. Important relevant factors are dosage, working conditions (temp, time, pressure), and stability of the emulsion in question, which determines product effectiveness. For many years oleic acid was the basis of excellent emulsion breakers; its carboxyl groups were converted into alkylated or arylated amides, the double bond sulphonated, and breakers after this principle were used to the end of the war. The first non-ionogenic breaker was oxethylated castor oil. Oxethylated alkylnaphthol proved especially effective in applicability. After the war colophony, whose chief constituent is abietic acid, was considered. As the decisive importance of alcohol, phenol, and naphthol derivatives lies in the length of the ethylene oxide chain, with succinic acid ester it lies with the alcoholic group. Phthalic acid ester, likewise sulphonated, has a better effect, but the acid is very corrosive. Application of breakers is discussed at length. 13 refs. R. T.

1270. Semi-micro method for chromatographic investigation of lubricating oils. (In German.) H. Spira. *Erdöl u. Kohle*, 1960, **13**, 27–32.—A method is described for chromatographic investigation of lub oils. Application possibilities of the procedure for studying and checking processing methods are explained by examples. In investigating lub oils aged in the motor or lab it is shown that the resin fractions obtained can be used as a criterion for the aging degree. In motor test runs an effort was made to relate the cyl picture to the results of the chromatographic analysis. The oil breakdown moment could be characterized by the sudden rise in resin cont. In investigating refinery behaviour of lub oils, valuable conclusions on structural changes could be drawn. Investigations in this direction were carried out in H_2SO_4 refining, selective refining with furfurol, and dewaxing with methylethylketone. 11 refs. R. T.

1271. Hydrocarbon research in Israel. A. Ben-Dow. *Petroleum, Lond.*, 1961, **24**, 186.—Research at the Weizmann Institute in Rehovoth under Dr E. Gil-Av is summarized. Among the topics mentioned is an examination of the Hague and Wheeler hypothesis, including the thermal aromatization of butadiene, reaction of butadiene with olefins, aromatization of aliphatic and naphthenic hydrocarbons, dehydrocyclization of *n*-heptane, and the equilibrium isomerization of *cyclo*-olefins. Other work of the Institute is mentioned briefly. Finally, references to published papers on the above topics are given. G. D. F.

ANALYSIS AND TESTING

1272. Glossary of current engine test methods for lubricating oils. C. O. R. Bell. *Petroleum, Lond.*, 1961, **24**, 181.—This paper presents a digest of information relevant to current specifications and standard engine tests for lub oils. Among those dealt with are military specifications (U.S., British, Belgian, French, German), Caterpillar Tractor Co specifications, API classifications, and IP and European Council tests. G. D. F.

1273. Measurement of undissolved water in aviation turbine fuels. Anon. *Engineer, Lond.*, 1961, **211**, 950.—BP "Aquascan" based on photo-electric measurement of light absorption, Two comparator cells, reference cell contains heated fuel in which all H_2O is in soln; measurement cell contains fuel as sampled but after passing through disperser to produce consistent particle size distribution and air separator to avoid errors due to entrained air (air also removed from reference sample). Scale reads in ppm (0–40), with alarm and shutdown at pre-set limit. Illustr and flow diag. V. B.

1274. Why and how of cable oil tests. A review. R. B. Blodgett. *Current Engng Practice (Bombay)*, 1961, **3** (9), 17–26. Slightly revised version of earlier paper (cf Abs. **612**, 1960), with additional refs. V. B.

1275. Transwestern makes on-the-spot sulphur analysis. W. A. Garratt. *Petrol. Engr*, May 1961, **33** (5), D20.—A portable, manually operated potentiometric electrolytic titrator is described, which is claimed to give rapid and reliable analyses of the sulphur cpds in natural gases. The method of use is described in detail, including the calibration of the instrument. G. D. F.

GAS

1276. Thermo electricity—a new demand for natural gas. C. Lawrence. *Oil Gas J.*, 10.4.61, **59** (15), 93–4.—There are four methods of converting gas into electricity. In the fuel cell, which consists of two porous electrodes separated by an electrolyte, the gas is fed into one electrode and air or oxygen into the other, with the resultant oxidn creating electricity. In the thermo-electric generator, heat raises the kinetic energy of the electrons at the hot junction above that at the cold junction and a flow of electrons occurs. The thermionic convertor consists of two electrodes in a vacuum or in cæsium gas and the cathode is heated, causing electrons to flow through the space to the anode and back to the cathode through an external electric circuit. The magneto-hydrodynamic convertor produces electricity when high-temp gas is moved through a strong magnetic field. The gas is heated to 3000°–5000° F to achieve conductivity. A. D. S.

LUBRICANTS

1277. Lubrication of gears in service. G. C. Mudd. *Inst. Petrol. Rev.*, 1961, **15**, 106–9.—After defining scuffing, wear, and pitting, the factors governing the choice of a lubricant for three important types of gear—parallel shaft, hypoid, and worm—are considered.

For spur or helical gears, straight mineral oils are adequate for all normal loading conditions and rules are laid down for choosing the correct visc grade of oil. The testing of such oils, the effect of surface finish of the gear teeth, and frictional loss are also discussed. For severe conditions of loading, EP additives may be necessary to prevent metal-to-metal contact. Other additives, such as anti-oxidants, and anti-rust additives may also be needed for special applications. The method of applying the lubricant depends on the peripheral speed of the gears, and sometimes it may be necessary to cool the oil to obtain a running temp of *ca* 140°–160° F.

With hypoid gears an EP oil is required to provide a film of low shear strength on the surfaces.

For worm gears, the correct visc grade or oil is specified, although EP additives are necessary for severe conditions.

Other factors influencing the choice of lubricant, such as good visc–temp properties and high temp oxidn stability, are also discussed. A. D. S.

SPECIAL HYDROCARBON PRODUCTS

1278. Solvents for nitrocellulose lacquers. I. L. M. Barakan. *Paint. Tech.*, May 1961, **25** (5), 21–9.—Solvent systems in nitrocellulose lacquers have been broadly classified into the following three categories. True solvents, such as esters, ketones, and glycol ethers; latent solvents, such as alcohols and diluents where aromatic hydrocarbons play a large part. A blend of solvents for nitrocellulose is therefore found to incorporate at least three components, and the following properties of these solvents are discussed—solvent power, effect of latent solvents, dilution ratio, evaporation rate, solvent retention, blush resistance, flow, odour, toxicity, flammability, and economics. A. D. S.

1279. Improving stability of phenol-extracted transformer oils from high-sulphur crude. M. F. Sadchikova and D. O. Gol'dberg. *Khim. Tekh. Topliv i Masel*, 1960, **5** (12), 18–24.—Transformer oil obtained by phenol extraction and dewaxing from Tuimazev crude can be brought up to U.S.S.R. national standard (GOST 982–56) by: (*a*) acid refining (½% of 95%, room temp); (*b*) hydrogen refining (350° C, 40 atm, Al–Co–Mo cat) followed by steam stripping; (*c*) percolation (silica gel, 60° C); (*d*) addition (3–5%) to dewaxed raffinate of natural inhibitors (fraction having $n_D^{50} > 1{\cdot}53$ separated by adsorption (desorbed with C_6H_6) from phenol extract) followed by earth contacting (60°–70° C, 8–10% earth). Inhibiting action due to aromatic S cpds. Of above methods (*d*) is preferred. Resulting oil has acidity development 0·26 and p.f. within permitted limit (max 0·003/20° C, 0·025/70° C). V. B.

1280. Causes of dielectric loss in transformer oil at 50 c/s. (In Russian.) R. A. Lipshtein and E. N. Shtern. *Inzhener. Fiz. Zhur.*, 1960, **3**, 101–4.—Critical value of H_2O concn in oil at which sharp increase in tan δ occurs rises with increasing temp (results for 20°, 50°, 75° C). Tan δ measurements at same temp on transformer oil additioned with ½% of various oxygen-containing org cpds (acids, alcohols, ketones, peroxides) show that such have no effect on dielectric loss. Conduction in liq dielectrics caused by impurities is not due to ions but to emulsion with water, giving rise to cataphoretic conductivity. In case of org acids dissolved in oil reaction of these with cell electrodes, giving rise to products increasing oil conductivity, may occur. V. B.

DERIVED CHEMICAL PRODUCTS

1281. Propylene again in limelight. H. A. Mitchell. *Oil Gas J.*, 10.4.61, **59** (15), 115–16.—The largest demand for propylene is for the manufacture of *isopropyl* alcohol and acetone. The second largest chemical requirement is in the production of low mol wt polymers, the most important of which are propylene trimer and tetramer used in manufacturing synthetic detergents. Other uses include the production of higher alcohols and aldehydes and glycerine. Looking to the future, the most promising and also most competitive fields for propylene utilization are the polyolefins.

The major portion of the available propylene is produced in petroleum refinery cracking operations, and the potential is estimated to be in the range of 20 billion lb pa. A. D. S.

COAL, SHALE, AND PEAT

1282. Chemism of coking, investigated on polymeric coa model materials. V. Model material pyrolysis with functional groups. (In German.) P. M. J. Wolfs, D. W. van Krevelen, and H. I. Waterman. *BrennstChemie*, 1959, **40**, 314–26.—Investigation of pyrolysis mechanism of model materials with functional groups, *e.g.* O_2-groups, indicates similarity in many aspects to that of so-called non-functional model materials. Depolymerization under disproportioning of the non-aromatic H_2 is of considerable importance, and coking occurs in two phases—to be clearly differentiated—namely, primary coking with tar formation, and *sec* coking solely with final gas formation. In contrast to non-functional model materials, selectivity of tar and gas formation—primary and *sec* coking—is much less sharp, obviously because side chains and side groups are split off simultaneously with the bridge system. Another result of the presence of functional groups, however, is a *sec* reaction opposed to depolymerization, *i.e.* condensation with phenolic model materials with cleavage of simple cpds—in extreme cases preponderating—so that absolutely no depolymerization takes place, thus no tar formation. O_2-function stability in the pyrolysis becomes obvious in this investigation and is shown to increase in the order: acetal < aliphatic ethers < aliphatic–aromatic ethers < phenolic hydroxyl < aromatic ether < quinone group. 15 refs. R. T.

CORROSION

1283. Measurement of coating leakage conductance. 2. M. E. Parker. *Petrol. Engr*, April 1961, **33** (4), D33.—The review of measurement methods is completed, and eight possible cases and methods are discussed. Finally, the calibration of the test section is dealt with.

G. D. F.

SAFETY PRECAUTIONS

1284. Economics of a sound safety programme. Pt 4. How to analyse a safety programme. J. H. Herbert. *Oil Gas J.*, 27.2.61, **59** (9), 109–11.—In analysing a safety programme, nine questions should be raised to determine if sound safety practices exist and to decide if they are being followed. (1) Is there a company safety policy and if so, is it known by all employees and is it referred to regularly by all levels of management? (2) In securing references for job applications, is information obtained as to applicant's safe work performance in prior employment? (3) Is there a formal safety indoctrination programme for new employees? (4) Is there a definite posted programme for the use of personnel protection equipment? (5) Is there a formal recorded safety inspection for equipment? (6) Is there an off-the-job safety programme? (7) Do all supervisors point out, in detail, hazards of job assignments both at the time employees are assigned to a job and subsequently at regular intervals? (8) Is there a formal, prompt investigation by immediate supervisor of all injuries, including minor ones? (9) Is safety performance included in employee-performance reviews for all employees, including senior personnel?

A. D. S.

1285. Intrinsically safe earth-proving equipment. Anon. *Engineer, Lond.*, 1961, **211**, 215.—Transformer/relay unit for use as earth-proving device prior to loading road tankers with petroleum spirit. Secondary circuit is completed only when vehicle earthing is satisfactory, indicated by lamp. Can be linked with loading valve, so that loading cannot start till vehicle earthed.

V. B.

ECONOMICS AND MARKETING

1286. World tanker statistics final quarter 1960. Anon. *Inst. Petrol. Rev.*, 1961, **15**, 128–9.—Oil tankers under construction in the world fell by 109,890 tons during the final quarter of 1960 to 229 ships of 3,925,474 gross tons. These comprised 96 steamships and 133 motorships, representing 45·3% of all merchant shipping then being built. Britain led in tanker registration, with Norway second and Liberia third. At the end of 1960 British yards were building 56 oil tankers totalling 806,527 gross tons. Sweden followed with 24 ships of 552,459 tons, and Japan was in third place with 33 tankers of 433,772 tons. Tabulated details are given of registrations, tankers under construction, and tankers launched during this quarter.

A. D. S.

MISCELLANEOUS

1287. The constructional model as an aid to more economic planning and construction of chemical plant. (In German). H. Reuter. *Chem. Ing. Tech.*, 1961, **33**, 313–18.—The paper deals with the usefulness of three-dimensional models in the design, planning, and construction of chemical plant. It is shown that the use of such models leads to more rapid construction and plant commissioning, and in this way there is often a reduction in costs.

G. D. F.

1288. Worry over today's surplus clouds oil's view of rosy future. G. T. Ballou. *Oil Gas International*, May 1961, **1** (5), 34.—Statistics are presented to show that there should be a vigorous increase in free world demand for crude oil over the next few years, and this will need increased production from all areas. There is too much emphasis at present on the existing surplus of oil and too little on the future expansion of demand. Charts show how oil demand has increased in relation to reserves, production, refining capacity, and oil consumption. Present economic problems in the industry are similar to those met in the past, excepting the introduction of nuclear fuels. These will not seriously compete with oil for very many years for economic reasons, and oil will occupy a favourable position amongst other fuels because of its competitive price.

C. A. F.

1289. Italians set new horizon for chemical industry. B. Orsoni and M. Ottolenghi. *Oil Gas International*, May 1961, **1** (5), 40.—Recent developments in the Italian petrochemical industry are reviewed. Italy is now the fourth largest chemical producer in W Europe. Petrochemicals were first produced in 1950 at Ferrara, and there has been rapid development since. The main fields are in plastics, synthetic fibres, and synthetic rubbers. Tables show chemical production data.

C. A. F.

1290. Engineering, Marine, Welding, and Nuclear Energy Exhibition. Anon. *Petroleum, Lond.*, 1961, **24**, 188.—Items of interest to the petroleum industry at the above Exhibition (20 April–4 May, London) are reviewed, including a number of types of valves, valve control units, pumps, motors, thermometers, CO_2 and orbital welding, shot blasting units, air compressors, and titanium and aluminium plant.

G. D. F.

1291. Applied hydrocarbon thermodynamics. Pt 23. W. C. Edmister. *Petrol. Refin.*, Nov 1960, **39** (11), 233–42.—Charts have been presented for the determination of fugacity coeff for components of vapour mixtures from both the Joffe and Redlich–Kwong equations. Vapour fugacity coeff calculated for *n*-butane and *n*-hexane in different hydrocarbon mixture solvents, at varying pressure and temp, were compared for the later methods as well as the Lewis Randall equation, Benedict–Webb–Rubin equation, and Edmister and Ruby correlations.

M. J. M.

BOOK REVIEWS

Industrial Organic Nitrogen Compounds. Melvin J. Astle. London: Chapman and Hall; New York: Reinhold, 1961. Pp. vii + 392. 112*s*.

This volume is No. 150 in the American Chemical Society Monograph Series and sets out to be a comprehensive survey of all compounds of present and potential commercial significance.

The work is divided into eight chapters. The first three deal with aliphatic amines, arylamines, and heterocyclic amines, the latter chapter treating the chemistry of the simpler nitrogen-ring compounds in some detail. A discussion of hydrazines, hydrazides, and semicarbazide in Chapter 4 leads to sub-sections dealing with hydrazobenzenes, azoxy compounds, azo-compounds, aryldiazonium salts, and oximes; it would have been more logical to include the chemistry of diazonium salts in the chapter concerning arylamines.

Chapter 5 concerns nitriles and amides; amino acids are also included here, presumably because the Strecker synthesis from aldehydes involves the formation of an intermediate cyanohydrin. *Iso*cyanates, ureas, and thioureas are discussed in Chapter 6, which also mentions their importance in the formation of polymers (polyurethane and melamine types), "urea adducts," and pharmaceuticals.

The seventh chapter dealing with aromatic nitro compounds introduces one of the rare discussions of reaction mechanisms and electronic theory. In this instance the mechanism of nitration and the orientation of nitration products is dealt with. The preparation of nitrobenzenes by oxidation of anilines can be found in Chapter 2. A subsection is devoted to nitroso-compounds.

The final chapter returns to aliphatic chemistry in continuing the discussion of nitro-compounds. This is the most readable part of the book, and no doubt reflects the close interest of Professor Astle in this branch of chemistry.

Each chapter has a similar format. A general introduction to the class of compounds is followed by relevant preparative methods. The reactions of the group with other classes of chemicals are listed, often in the manner of a catalogue, and only occasionally is an attempt made to discuss reaction mechanisms. It is, however, a pity that the example of Chapter 1, which contains a sub-section dealing with the industrial applications of aliphatic amines and their derivatives, is not followed consistently throughout the book.

One useful feature of the book is the inclusion of nearly 1700 references to original papers and patents up to and including those in 1958. In view of this one wonders why it has been found necessary to include potted preparations in the text. Whether the most significant references are quoted is a matter of opinion.

It is possible to find a number of typographical errors. Some statements, such as "Amides may be converted to thioamides by the action of phosphorus pentasulphide and by the addition of hydrogen sulphide to nitriles," arise from a tendency to compress as much information as possible into the space available.

References to the patent literature help to give an indication of the direction of thought of industrial laboratories, but in view of the delay between application and publication dates, it is doubtful whether this gives a true indication of current developments. An uncritical approach to patents might also mislead one into believing that a compound claimed as having high activity for a particular use would necessarily be a commercial success in that application.

The reader is left with a degree of dissatisfaction that some topics are not dealt with more fully. In view of the title of the book, it seems a pity that more emphasis has not been placed on the industrially used nitrogen compounds—one thinks of compounds such as cyanogen chloride and the synthetic musks.

Many of the reactions discussed have been dealt with better elsewhere, and the industrial implications are more clearly defined in, say, the "Encyclopedia of Chemical Technology" (Kirk–Othmer) or the "Encyclopädie der technischen Chemie" (Ullmann). However, this book is valuable in that the chemistry of most types of organic nitrogen compounds are dealt with in one volume, and the mass of information contained therein should serve to stimulate further research in this field. This is a reference book which should be of interest to all chemists—if they are not misled by the title.

J. Y.

Chemisch-Physikalische Grundlagen der Verwendung von Erdöl und Seinen Produkten. A. Philippovich. Vienna: Springer-Verlag, 1960. Pp. xii + 333. 126*s*.

The petroleum industry has made great strides since the heyday of the kerosine lamp. This development was sometimes turbulent and in many respects spectacular, particularly as *ad hoc* methods were the order of the day and often still are. It may well be said that the present *embarras de richesse* with regard to the production of petroleum and natural gas can be attributed to the slow realization of the need for a vigorous application of scientific thought and method to the uses of petroleum and its products. The climate is therefore just right for a treatise on the subject which Dr Philippovich has chosen. However, as the available information is widely scattered in the scientific and technical literature, and as there is hardly an industry these days that does not use petroleum products in one form or another, the question arises whether the writing of a book with the scope aspired at by Dr Philippovich is not too ambitious an undertaking for one single person.

The book under review is certainly not a text-book and not a guide for the beginner, but it contains so many data that it should present a useful reference book for the initiated. The expert will not be too much disturbed by the numerous misprints. For example, the Reynolds' number is given as $R = \rho \,.\, d \,.\, v \,.\, \eta$ (p. 32) instead of $R = \rho \,.\, d \,.\, v/\eta$; reference is made to "F. Hardy" where it should read Sir William B. Hardy (p. 111); L. Ubbelohde's name is spelt wrongly throughout the book; H. Blok has only once been given an excessive "e"; the "g" of "Schmierung" has been missed out in the diagram on p. 108; there is no such word as "Anormalitäten" (p. 47), they are either "Anomalien" or "Abnormalitäten." But these are very minor points. What is more serious is the treatment of the subject matter. More space has been devoted to the description of determining the Reid vapour pressure than to the whole field of mass spectrography. The second law of thermodynamics occupies one page and five lines. Just over two pages are taken up with the Bohr model of the atom; they cannot be of any use to a reader who has been trained in spectroscopy, and they are of no help to the novice.

This book shows the dangers of plausibility arguments and of a technical jargon which is often misinterpreted as if it were of some physical significance. One author is quoted with his postulation (p. 112) for the force of friction $= A\{\alpha \,.\, s_m + (1 - \alpha) \,.\, s_l\}$ [where A = load-carrying area, α = the proportion of this area over which metallic contact takes place, s_m = shear strength of the metallic bridges, s_l = shear strength of the lubricant film] as proof

that the properties of the solid surfaces should play a major part in determining the magnitude of the force of friction under conditions of boundary lubrication. However, such a simple connexion is as yet unproven. Anyhow, how would an engineer assess the numerical values of α, s_m, and al? The present state of the art of lubrication has been put in a nutshell in three lines on p. 153. There one reads: "Lubricating oils for gas turbines are largely synthetic materials to which a more general testing method cannot be applied; one relies, as in the case of *motor oils*, on practical performance tests, particularly with aviation lubricants." There could be no better example to show the crying need for bringing scientific thought to bear on the problems of petroleum technology. The same applies to a number of problems other than lubrication. One of these is engine knock, with which the author deals at some length. Viscometry is treated fairly fully, but again the impression is conveyed as if temporary viscosity reduction (p. 47) were an anomaly. It is nothing of the kind, but a property which any liquid containing non-spherical molecules exhibits at sufficiently high rate of shear.

The IP and ASTM have reached agreement on the abbreviation cS for centistokes, and one would wish to see this more widely adopted. In the U.K. two qualities of transformer oil, A-30 and B-30, were made before the last war. A-30 has since been dropped. Table 91 on p. 263 contains the British Standards specifications BS 148/1933 and BS 148/1951, together with the statement that class B oils are no longer available!

With these cautions the book can be recommended for reference purposes. R. S.

Gas Chromatography. Ernst Bayer. Amsterdam: Elsevier, 1961. Pp. xii + 240. 25*s*.

This volume is the English edition of a book first published in German in 1958. Although the author claims to have included more recent work on capillary chromatography, quantitative analysis, ionization detectors, and preparative chromatography, the treatment of these subjects is still very much out of date.

The book, written presumably for the practical worker, deals very briefly with the theoretical aspects of chromatography. The concepts of retention volume, height equivalent to a theoretical plate, and the determination of partition and activity coefficients are described, but only brief reference is made to the van Deemter equation. Unfortunately the theoretical discussion is marred by a poor choice of symbols and a number of errors that lead to confusion on the part of the reader.

Chapter 3 is concerned with the construction of columns. Both adsorption and partition type columns are considered and their suitability for various specific separations discussed. The chapter includes useful tables giving the more common stationary phases outlining their temperature range and specificity. These tables are supplemented at the end of the book by a valuable compilation of selectivity coefficients and retention volume data.

Sample introduction, detectors, thermostats, and fraction collectors are featured in the chapter on apparatus. Detectors are also dealt with more fully in a later chapter, prime importance rightly being given to the katharometer. The treatment of ionization detectors is very scanty and lacks any critical evaluation of the various types.

Undoubtedly the best chapter (and indeed the longest) is that dealing with practical applications. The author first discusses the principles of quantitative analysis and then illustrates the versatility of the technique by showing how it has been applied to a wide range of analytical problems.

The book is reasonably priced and includes a bibliography containing over 400 references. A. G.

Gas Sampling and Chemical Analysis in Combustion Processes. G. Tiné. Oxford: Pergamon Press, 1961. Pp. xv + 94. 42*s*.

The task of preparing this book was undertaken by Professor Tiné at the request of AGARD, and it was written as a result of visits to about 30 research laboratories in Europe and the U.S.A. It is a digest of current practice in these laboratories, summarized under the twin headings of the Sampling Process and Methods of Gas Analysis. As the aircraft field is the prime interest of AGARD, it is perhaps not unfair that continuous combustion only should be considered. Little or no attention is devoted to the interesting work which has been done in the reciprocating engine field.

The first half of the book is devoted to the techniques of sampling and the errors which can arise if the aerodynamic problems of sample flow into the tube, and the chemical problems of quenching of the sample, by convection, by dilution, or by expansion, are not overcome. The catalytic effect of the sampling tube wall is considered. This is of little importance in the analysis of gases such as carbon monoxide, hydrogen, etc., for the determination of combustion efficiency. It can, however, be very important when sampling for such unstable intermediates as organic peroxides and where the amount of surface cooling which may be used is limited by water condensation.

The second half of the book, on methods of analysis, is perhaps less satisfactory than the first. The rate of progress in analytical techniques has been so rapid in recent years that inevitably much is out of date or of diminished interest by the time it is published. As the author himself points out, instrumental procedures are more and more superseding the classical chemical methods, and developments in gas chromatography, for instance, have been so rapid in recent years as to have completely revolutionized some aspects of gas analysis. Organic peroxide analysis is given a section on its own, but relies mainly on an unpublished report of 1946. A great deal of work has been published since then, and the student would welcome some guidance to this literature.

The author and his publishers apologize in advance for the narrowness of the subject matter of their book. This may be true, but the subject is nevertheless an important one, and Professor Tiné has compiled a useful introductory handbook for a research worker entering this field for the first time. D. D.

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OILFIELD EXPLORATION AND EXPLOITATION

GEOLOGY

1292. Application of hydrodynamic theories in the search for oil. (In French.) G. A. Hill and J. Knight. *Bull. Ass. franç. Tech Pétrole*, Nov 1960, (144), 937–8.—Hydrodynamic behaviour must be added to structural and lithological factors in considering the trapping of hydrocarbons. The direction and value of the hydrodynamic gradient are important in fixing the accumulation capacity of various traps. Pressures are important factors in exploration. G. D. H.

1293. Geological factors influencing porosity estimates from velocity logs. R. Sarmiento. *Bull. Amer. Ass. Petrol. Geol.*, 1961, **45**, 633–44.—The velocity log is a satisfactory tool for making velocity estimates. However, the widely used time–average equation by itself does not give, in many cases, precise enough porosity values. This is especially true where variables such as depth, shaliness, and age should be considered for accurate porosity estimates.

The travel time–porosity relations for sandstones depend on geological factors such as the rock's age, composition, depth, tectonic history (compaction), shaliness, and type of fluid in its pores. Of these parameters, depth and shaliness are the most important. Travel time–porosity relations were computed by statistical methods, which took into consideration the variables mentioned. The resulting equations give more accurate porosity estimates than the time–average equation, which is in widespread use. E. N. T.

1294. Characterization of the San Miguel sandstone by a co-ordinated logging and coring programme. C. F. Knutson *et al. J. Petrol. Tech.*, 1961, **13**, 425–32.—Most of the wells of the

Sacatosa field, Maverick County, Texas, were logged under very similar conditions, and commonly within a few hours of drilling through the San Miguel-1 sand. When there was delay in logging the wells usually had a slight positive separation on the microlog curves in normally productive zones compared with a slight negative separation when there was no delay. Mud cake and filtrate resistivity values should be measured on mud caught during circulation just before logging. Repeat runs sometimes showed marked differences for hard streaks under 1 ft thick, possibly due to differences in sonde orientation.

Although cores appear homogeneous, detailed tests showed significant variations over an area only 3½ inches dia. The sandstone is fine to very fine grained sub-angular, felspathic to lithic greywacke. There are borings, fossil casts, and discontinuous shale streaks, seldom over 5 cm long. Some hard streaks indicated by logs may approach but not intersect the well. The producing sections appear uniform throughout the drainage area of a well. Dense zones seem not to extend laterally more than *ca* 50 ft. The reservoir is a stratigraphic trap on an irregular E and SE dipping monocline. Flowing wells lay in a zone on a plot of porosity *v.* water saturation with an upper limit defined by $\phi = 25\%, S_w = 40\%$ and $\phi = 29\%, S_w = 55\%$, and a lower limit of $\phi = 18\%, S_w = 47\%, \phi = 22\%, S_w = 50\%$ and $\phi = 24\%, S_w = 57\%$. G. D. H.

1295. In offshore Louisiana, some commercial oil, gas indigeneous to Pleistocene. D. I. Andrews and J. C. Stipe. *World Oil*, June 1961, **152**, (7), 122.—Drilling offshore from the S Louisiana coast and along the Mississippi River delta has led to the finding of commercial gas and some oil in Pleistocene marine sands. Lucrative production had already been found in deeper Pliocene and Miocene sands. Sand developments and accumulations are similar in the younger Pleistocene, showing cyclical transgressive–regressive deposits with reservoir properties improving down-dip. Nearshore accumulations are probably derived by seepage from older beds, but the major Pleistocene accumulations are thought to lie down-dip in an intermediate alternating marine sands and shales facies. Plio-Pleistocene geology of the area is discussed, and earlier theories that the oil could not be indigenous to the Pleistocene because of its youth can be discounted by studying the stratigraphy of the formation from well logs. There should be equally good prospects for development of commercial oil in the Pleistocene sediments elsewhere on the continental shelves. 25 refs. C. A. F.

1296. Utah holds interest in Rockies. J. C. McCaslin. *Oil Gas J.*, 5.6.61, **59** (23), 132.—The Utah area of the Rocky Mountains continues to be one of the most successful areas of exploration in the U.S.A. There is active drilling, and *ca* 100 wells were drilled in the first six months of 1961. These are in the Paradox Basin and Uinta Basin, and five new fields have been found this year. Main prospects are post-Pennsylvanian, but there are tests projected to the Cambrian. The chief target is gas, as there are proposals for more gas outlets from the area. Up to 1950 only four oil and gas fields had been found in Utah, but there are now over 40, with production from Tertiary through Devonian. The main area of interest is the Paradox Basin, but the W part of Uinta should be favourable where formations are thick and stratigraphy is comparable with that on the E productive side. C. A. F.

1297. Stratigraphic evidence for tectonic and current control of Upper Devonian reef sedimentation, Duhamel area, Alberta, Canada. J. M. Andrichuk. *Bull. Amer. Ass. Petrol. Geol.*, 1961, **45**, 612–32.—In this study, details of the Upper Devonian stratigraphic interval discussed is limited to the Woodbend group. In the Duhamel area the section under study comprises in ascending order: (1) Cooking Lake formation; (2) basal calcilutite of the Duvernay formation; (3) Leduc reef; and (4) Ireton formation. In off-reef sections the Duvernay consists of basal calcilutites and argillaceous beds overlain by bioclastic limestones and an upper sequence of brown and black shales and calcilutites, overlain by the Ireton formation.

Samples of the Cooking Lake and Duvernay formations from 70 wells were examined. Lithologic data were used to construct isolith, isopach, and lithofacies maps and critical stratigraphic cross-sections, from which the sedimentation patterns preceding and accompanying early reef growth were interpreted. E. N. T.

1298. New Devonian and Mississippian formations in De Long Mountains, Northern Alaska. E. G. Sable and J. T. Dutro, Jr. *Bull. Amer. Ass. Petrol. Geol.*, 1961, **45**, 585–93.—In the Central and W De Long Mountains the sequences described in this report were first recognized.

The Kugururok formation (Late Devonian age) consists largely of dolomite and limestone with minor shale, sandstone, and conglomerate, and is probably more than 2000 ft thick. The Mississippian Lisburne group is divided into three marine formations: the Utukok, Kogruk, and Tupik. The Utukok formation consists mostly of ferruginous sandy limestone, calcareous and quartzitic sandstone, and calcareous shale, and is at least 2500 ft thick. The Kogruk formation is of thick-bedded, fine to coarse-grained, grey limestone with minor beds and lenses of chert, and is 1500 ft thick. The Tupik formation is predominantly dark grey to black, finely crystalline limestone and black chert and is as much as 700 ft thick.

Geographic distribution of these units is shown, and they are compared with other Devonian and Mississippian sequences. E. N. T.

1299. Geology and tectonic setting of Lower Kuskokwim–Bristol Bay region, Alaska. J. M. Hoare. *Bull. Amer. Ass. Petrol. Geol.*, 1961, **45**, 594–611.—The lower Kuskokwim–Bristol Bay region is in a tectonically active belt which borders the Pacific Ocean. The region has been subjected to strong compressive forces operating NW and SE, and strata of Cretaceous age and older are compressed into tight folds and broken by numerous faults. Faults that intersect young surficial deposits in the region indicate that mountain-building movements are still taking place, but not nearly so strongly as farther S in the Aleutian Islands.

The rocks range in age from pre-Cambrian to Quaternary. Except for continental volcanic rocks of Tertiary and Quaternary age, the formations were deposited under geosynclinal conditions. The Kuskokwim group is characterized by coarse-grained clastic rocks which were derived from local geanticlinal uplifts and deposited in the Kuskokwim geosyncline. Several lines of evidence show that these rocks were deposited rapidly and constitute an unsorted "poured-in" sediment of low porosity. E. N. T.

1300. Oil in Africa. 2. Oil developments and aspects of petroleum geology in North and West Africa. C. A. Fothergill. *Petroleum, Lond.*, 1961, **24**, 221.—The recent developments and discoveries in Algeria and Sahara are outlined briefly, and the geology of the various basins is discussed. Then the rather smaller production in Morocco, Nigeria, Gabon, and Angola is mentioned, together with geologic details and the outlook for future developments. G. D. F.

1301. Major exploration boom is in prospect for Australia. R. C. Sprigg. *World Oil*, June 1961, **152** (7), 143.—A rapid expansion of exploration in Australia is expected during 1961 and next year. The continent has many large, deep sedimentary basins with favourable structures, and modern exploration methods promise significant discoveries. The basins cover more than 1½ million sq miles, and few wells have penetrated the full section, which is 20,000 ft or more in the deeper areas. Most drilling has been based on oil shows in shallow water wells, and modern techniques of geological and

geophysical control have not yet been fully applied. Prospects and developments in the main basins are reviewed. Maps show leases in Australia as at mid-year, 1960.

C. A. F.

1302. Study of the kerabituminous rocks of the Paris Basin. I. Bajocian marls. (In French.) Y. Khalifeh *et al.* *Rev. Inst. franç. Pétrole*, 1961, **16**, 135–9.—The Paris Basin has several types of oil. At least four types can be recognized by the C/H ratio of the fraction boiling above 240° C, and these occur in the Neocomian, Dogger, Rhaetic, and Carboniferous, being, respectively, naphthenic, mixed, and paraffinic base. The most important accumulations are in the Jurassic, especially the Dogger, and this has been the first study. It was concluded that the Bathonian oil came from above the Bajocian reservoir. The Bajocian marls are at least 10 m thick and attain 40–50 m. 206 samples from 14 boreholes were analysed for insoluble organic carbon, and by integration contours of equal amounts of organic carbon were obtained. The 1% contour included all the Bathonian fields. For a density of 2·2 and mean thickness of 10 m, there would be 330,000 tonnes/km² of organic matter, which at 3% conversion to oil would give 10,000 tonnes/km². The 1% contour includes 10,000 km², and hence for only 30% recovery there are possibilities of important amounts of oil in the Bathonian.

G. D. H.

1303. Analysis of salt plug uplifts by electrical drill hole measurements on salt plugs Bramstedt and Etzel. (In German.) K. Rödiger. *Erdöl u. Kohle*, 1960, **13**, 149–53.—In an oilfield with borings in flat distribution diagrams of elec resistance and potential measurements make possible presentation of each formation step in a map. In Bramstedt field this was carried out from Hauterive for all stages of Cretaceous and Tertiary to Oligocene. Individual stages show in their thickness curves (isopachs), a very different picture, both in direction of the curves and fall of thickness transversely. In several stages of equal thickness the fall presents an abs measure of the salt plug lifting. Such numbers referred to 100 give $\frac{\text{Fall} \times}{\text{thickness } 100}$ = Specific thickness fall. Specific thickness fall is based on a somewhat reduced sedimentation or wear during lifting. Major phases in the lifting are presented in a columnar diagram and discussed. The same method is applied to Etzel field. The halokinesis treated by Trusheim is confirmed by the diagrams presented. Continuous lifting is observed in both salt plugs. As regards the orogenic phases Trusheim concedes that presence of stresses in times of regional tectonic unrest may have come to solution. The Bramstedt and Etzel diagrams show, however, that liftings during the orogenic phase, in part, were very strong in relation to the quiet intermediate times. This leads to the assumption that halokinesis during the orogenic phases has become very strong. By these methods the orogenic phases clearly can be detected. Nine refs.

R. T.

1304. Scheerhorn petroleum deposit. (In German.) W. Fischak. *Erdöl u. Kohle*, 1960, **13**, 69–78.—Scheerhorn petroleum deposit W of the Ems, near the Dutch border, belongs to the Emsland group. Strata series—characterized by three transgressions—extends from Liassic *d* into Quaternary. Micropalæontological discovery shows that under deposition of Upper Liassic, Dogger, and parts of Malm, Upper Malm transgresses over Liassic *d*. The "Old Saddle" in N is determinative in facies and thickness for all Upper Malm, Wealden, and Lower Cretaceous deposits. The second transgression follows in the higher Lower Cretaceous. Apt or Alb overlaps from S to N transgressively. An approx complete strata series exists on the S edge of Scheerhorn field. Over Upper Malm lies Wealden, followed by Valendis Hauterive, Barrême, Apt, and Alb. In N Alb lies—in the "Old Saddle" region—on the Upper Malm, further N on the Liassic, and strata thinning and small transgressions determine deposition. Upper Cretaceous thickness decreases from N to S following the rising anticline in S primarily, and by topping due to Tertiary transgression. Rise of the "Old Saddle" up to Alb time in N—released by Georgsdorf saddle in S—gives a strata tilt of 8°–10° in N. In Scheerhorn oil has been found in six formations, four economical. The deepest known producing strata are Upper Malm transgression (Gigas strata). Thickness and facies distribution indicate a high formation at transgression time in N. Gigas strata thickness diminishes continually from S to N. Serpulite contains an economical oil filling. Reservoir rocks, shell lime breccia, and ostracods are a few to 2·5 m thick. The formation has a flat NE–SW directed structure which by a practically E–W striking—falling to S disturbance—is divided into two fault blocks. Depth difference between highest watered and lowest oiled deposit faults is 11·5 m. Observing the picture on a Tertiary basis, the limit line runs on a horizontal. Following the Serpulite structure back into pre-Alb time only a S-tending dip was present. In NW a subsurface map shows still Serpulite as structural element, in E the E–W-striking anticline. The most important deposit of Scheerhorn field was formed in the Valendis in Bentheim sandstone, which forms a flat E–W striking structure permeated by disturbances. In N the deposit is bounded by the Alb transgression, in W by the Recent Tertiary disturbance. Geological development is described. Up to Alb time sedimentation and tectonics in Scheerhorn space were determined by the N high position. The highest and last deposit is in the Gildehauser sandstone. Deposit formation and history of Bentheim sandstone deposit are discussed.

R. T.

GEOPHYSICS AND GEOCHEMICAL PROSPECTING

1305. Studies on seismic models. M. Lavergne. *Rev. Inst. franç. Pétrole*, 1961, **16**, 5–35.—Ultrasonic elastic impulses have been used in models for investigating mathematically difficult seismic wave propagation problems. Plexiglass and duralumin sheets not thicker than 5 mm were used. A piezoelectric energy source was employed, together with a piezoelectric receiver.

For a dilational wave incident on a perfectly reflecting half plane the distribution of dilational and distortional waves issuing from the end of the diffractor was studied. The emitter was placed to give incidence of −9°, 0°, and +9° on the end of the diffractor. The results are essentially those for an infinitely thin zone provided that its thickness is less than a quarter of the wavelength of the incident pulse.

Refraction in models employing various thicknesses of duralumin between plexiglass has been investigated. The speed of the refracted longitudinal wave was a function of the thickness of the duralumin layer. The amplitude of the arrival diminishes with increased distance and falls off more rapidly the thinner the bed.

G. D. H.

1306. Results of surface geochemical studies in the vicinity of the Djebel Haricha field (Morocco). (In French.) B. House. *Rev. Inst. franç. Pétrole*, 1961, **16**, 140–9.—The analyses were made by finding the amount of organic matter dissolved by chloroform in Soxhlet apparatus. The composition of the extracts was not determined.

The Haricha field is 900 m deep in Dogger limestones and sandstones, and in Burdigalian limestones. The accumulation covers 100 ha. There is a marl cover. 1-kg samples were taken at 4 m depth from holes 100 m apart. Study of a pair of profiles showed no relationship between soluble organic matter and the outcropping formation. A positive anomaly was shown in the fissured cover in the SW of the field; a negative anomaly surrounded by a halo was seen in the non-

disturbed part in the NE. It appears that spacing of 200 or 300 m could have been used. Contours of the geochemical values and also serial profiles show highs over the fault, and elsewhere a low over the area of accumulation. G. D. H.

DRILLING

1307. Exploratory drilling in 1960. J. B. Carsey. *Bull. Amer. Ass. Petrol. Geol.*, 1961, **45**, 701–27.—This is the 16th annual report on data gathered and compiled by the Cttee on Statistics of Exploratory Drilling, and the 25th article of its kind.

In the U.S.A. during 1960, 11,704 exploratory holes were drilled; 2189 of these produced some oil or gas, representing 18·70% of all exploratory effort. The total exploratory footage drilling 1960 was 55,830,684 ft, with an average depth of 4770 ft/hole. These figures compare with 63,252,521 ft drilling in 13,191 exploratory holes, with an average depth of 4795 ft in 1959.

There were 7320 new field wildcats, 745 of which produced some oil or gas, representing 10·18% of all new field wildcats. New pool tests (including new pool wildcats, deeper pool tests, and shallower pool tests) for 1960 totalled 1953 holes, 616 or 31·54% of which produced some oil or gas.

For the second time data are presented on natural gas reserves in the 17-states area by years, for discoveries having six years of development history. E. N. T.

1308. New turbo-drill simplifies directional drilling. S. R. Ghavami. *Petrol. Engr*, June 1961, **33** (6), B34.—This paper, by a drilling engineer who worked recently in the Baku field, describes some improvements to the turbo-drilling technique developed in the U.S.S.R. The construction of the modified turbo-drill is outlined. Many advantages are claimed, particularly in directional drilling, ease of orientation, etc. G. D. F.

1309. How pipe and hole size affect drilling hydraulics. P. L. Moore. *Oil Gas J.*, 29.5.61, **59** (22), 143.—Poorly chosen hole and pipe sizes are often the reason for poor hydraulics and high drilling costs. The effects of hole and pipe size and well depth on the variation of pump pressure with flow rate are discussed. If surface pressure in the mud system is limited it is often impossible to utilize the pump hp available, particularly in holes over 5000 ft deep. This sometimes sets a limit to the advantages of slim-hole drilling. J. C. M. T.

1310. Who drills wells? Anon. *Drilling*, June 1961, **22** (9), 60–1.—The wells drilled by the producers themselves and by drilling contractors are tabulated for 64 producing companies who drilled 26% of all wells drilled in the U.S.A. in 1960. Drilling contractors were relied on for 90% of the wells in the U.S.A. and for 97% of those outside. J. C. M. T.

1311. Project Mohole demonstrates deep water drilling technique. G. M. Wilson. *World Oil*, June 1961, **152** (7), 84.—The first phase of the Mohole project has been completed, and exploratory holes have been drilled in water depths of up to 11,700 ft. During initial operations off La Jolla, near San Diego, California, five test holes were drilled and cored in 3140 ft of water, the deepest being 1043 ft. In 11,700 ft water tests in the open ocean between Guadalupe Island and the Baja California coast, six holes were drilled down to 611 ft, finding Miocene over basalt. Details of the drilling operations are given; holding position to within only 200–300 ft directly above the hole was maintained with four outboard engines manœuvring the ship to stay in the centre of a buoy ring. Special engineering was necessary to design and predict the behaviour of the 4½-inch drill string, which hung from the vessel unrestricted by casing. All coring was done with wireline and all logs obtained through openings in the bit. The purpose of the project was to test floating vessel drilling equipment and techniques for drilling the deep Mohole test, whose site has not been fixed. C. A. F.

1312. Existing equipment plays major role in Mohole work. P. B. Harder. *Drilling*, June 1961, **22** (9), 62.—A feature of Phase II of Project Mohole was reliance on conventional oilfield equipment such as standard wt and torque indicators, mud pressure gauges, and diamond coring equipment. Dual elevators were used for the first time offshore to avoid damage to the drill string by slip teeth. Pipe was racked horizontally. A French turbo-drill was used briefly in one hole. J. C. M. T.

1313. The turnkey drilling contract. R. O. Frederick. *Drilling*, June 1961, **21** (9), 53.—The "turnkey" drilling contract is one under which the drilling contractor provides the operator with a well drilled, tested, and equipped to certain specifications, at an inclusive predetermined price. It is becoming increasingly adopted, but opinion is divided over the merits of the practice. The small independent operator may find the immediate economies invaluable, but large companies can probably compete on immediate costs and may (by closer control of completion practices in particular) achieve better ultimate recoveries at lower overall costs. J. C. M. T.

1314. Contractors' survival kit. J. Skeehan. *Drilling*, June 1961, **22** (9), 46–52.—Costs due to labour, maintenance and repair, overheads, equipment usage, and profit are considered as they affect the drilling contractor in California. Average daily labour costs are $448.02 for four-man crews and 536.08 for five-man crews. Maintenance and repair costs vary from $188.19/day for 4000-ft wells to $304.12 for 15,000 ft, and overheads from $196.03/day for 4000 ft to $185.54 for 15,000 ft. Cost of drilling machinery has risen *ca* 80% in the past ten years, 50% due to inflation and 30% due to the call for greater complexity; rising costs are taken into account in determining the equipment usage charge, which varies from $91/day for 4000 ft rig capacity to $281 for 20,000 ft capacity. Drill pipe deterioration is assessed at $25/day for pipe adequate for 5000-ft work to $158 for 20,000-ft pipe. Blow-out preventer costs are assessed as $20/day, and drill collars as $0.06/ft of 4¾-inch to $0·16 for 8-inch pipe. Profit is calculated on a return of 10% on present value of equipment, and varies from $109/day for a 4000-ft rig to $295/day for a 20,000-ft rig. All the costs are tabulated for a range of rig sizes. J. C. M. T.

1315. Field applications of abrasive-jetting techniques. R. S. Ousterhout. *J. Petrol. Tech.*, 1961, **13**, 413–15.—In 1939 sand-laden fluids were first used commercially for perforating casing. In 1958 tungsten carbide nozzles had a working life of 9 hr compared with a few minutes for the earlier hardened steel nozzles. Better jet designs were developed, and higher pumping rates are now possible; friction loss reducing agents have been introduced. Slight movement of the tool after penetration helps.

5000 abrasive perforating jobs have been done, with 90% success. It can also be used for enlarging open hole; it does not damage cement or formation. Up to 100 holes have been cut in one trip, and two lots of casing can be perforated. In open hole the well bore is cleaned in enlarging, and can be prepared for selective fracturing; casing can be cut for whipstocking. G. D. H.

1316. Improved compositions for cementing wells with extreme temperatures. G. W. Ostroot and W. A. Walker. *J. Petrol. Tech.*, 1961, **13**, 277–84.—Deep wells involve high temp, which affect the behaviour of cements. Moreover, there may be a considerable range of temp in the cement column. Coarse ground barytes has been found suitable for weighting, since additional water is not required. Ilmenite, as well as galena and iron arsenate, have been used. Silica flour inhibits strength regression at high temp, and can increase strength

and reduce permeability when bentonite has been added. Three to four hours thickening time may be desirable, calling for a retarder, and a modified lignin-type retarder has been effective with silica flour, diatomaceous earth, bentonite, and gilsonite, which may have been added to cements for other purposes. The cements can be adapted for temp up to 500° F, and the wt can be as much as 20 lb/gal. G. D. H.

1317. Formation cement squeezes using low-water-loss cements. H. J. Deach *et al. Oil Gas J.*, 29.5.61, **59** (22), 155–8.—New techniques used by Gulf Oil Corpn have increased successes in cement-squeeze jobs from 60 to 85%, and moreover, no cement need normally be drilled-out afterwards. Slurries used have low filtration rates and prolonged fluidity. These can be squeezed into perforations without dehydrated cement filling the casing. By prolonged intermittent pumping cement filter cake can be built up in open perforations until pressure can be increased to force cement into the more resistant perforations. The resultant filter cake can set strongly, while the parent slurry remains fluid and can therefore be washed out. These qualities are achieved by using a slurry with a water/solids ratio of 0·4 and an API fluid loss of 50 cc/30 min/1000 psi. Filtration is controlled by a sulphonated aromatic cpd and setting time by a calcium lignosulphonate retarder. J. C. M. T.

1318. Modern well completion series. Pt 12B. Oil well cementing practices and materials. P. C. Montgomery and D. K. Smith. *Petrol. Engr*, June 1961, **33** (6), B28.—This part deals with the materials used in oil well cementing. The various components of manufactured cements and their properties are discussed. The remainder of the paper gives a comprehensive survey of the various cement additives, their properties, reasons for use, etc. G. D. F.

1319. New logging unit could save you a fishing job. Anon. *Drilling*, April 1961, **22** (6), 110–11.—A new logging device makes use of a strain gauge to record transient changes of tension in drill pipe produced by changes in torque during rotation of the bit. Characteristic pulses are given by drilling in shale, sandstone, chert, limestone, and igneous rock. Seizing or loss of the cones of the bit and " key " seating also produce characteristic curves which enable the device to detect these faults immediately they occur. J. C. M. T.

1320. The sonic log and its applications. (In French). M. A. Poupon. *Bull. Ass. franç. Tech. Pétrole*, Nov 1960, (144), 939–49.—The sonde has an energy source and three detectors 3, 4, and 6 ft below. Short impulses are emitted ten times/sec, and the arrival times at two of the detectors are recorded. Simultaneously an SP curve is recorded. The sonde, 4½ inches dia, can withstand 130° C and 1000 kg/cm². The detector spacings used are 1 ft or 3 ft. Sometimes the first arrival does not activate the second detector, which may be triggered by a strong later arrival, giving skipping. Skipping occurs in very porous gas sands and in fractured rocks. Troubles due to noise from movement of the sonde in the well arise only rarely. Caving affects the record in opposite directions as the pair of receivers bridge the change in dia; it does not affect the integrated curve. Detail depends on the spacing used. The interval velocities can be used for correlation; they are good in thick clays and evaporites.

Porosities can be deduced in consolidated rocks. $\phi = (\Delta t \log - \Delta t \text{ matrix})/(\Delta t \text{ liquid} - \Delta t \text{ matrix})$. The liq is usually filtrate. For loose sands empirical corrections have been suggested. There are also difficulties in fissured rocks. G. D. H.

1321. How do you drill a well in 12,000 feet of water? Anon. *Drilling*, April 1961, **22** (6), 50–1.—The problems of drilling from a floating vessel in 12,000 ft of water have been studied mathematically in preparation for Phase I of the Mohole Project. It is predicted that pitch and roll of the ship will cause severe stresses in the top joints of pipe; the solution to this is use of a guide shoe 35 ft long and bell-mouthed downwards where the pipe passes through the hull. Drift of the ship is liable to break the drill pipe where it enters the sea bed; this danger is met by extending tapered-wall casing some distance up from the bed, to support the pipe flexibly. Whipping and transverse vibration of the unsupported pipe will be damped out by the water if rotary speeds do not exceed 40 rev/min. Resonance between wave frequency and longitudinal vibrations in the pipe will be reduced by pipe protectors. Bending by deep ocean currents is likely to be negligible. J. C. M. T.

1322. How to evaluate pipe stresses when drilling from a floating vessel. E. L. Lind. *World Oil*, June 1961, **152** (7), 95.—Additional stresses arise when drilling from a floating vessel, such as bending stresses due to ship roll, displacement of ship from over the hole, and ocean current drag force. With increasing drilling depth roll and/or displacement limits must be decreased to avoid overstressing. To combat these stresses the max allowable working stress must be determined, and these are analysed. Formulæ and diagrams are presented for determining stresses, and the effects of such factors as various hole depths, materials, water depths, and pipe sizes are considered. C. A. F.

1323. How safety is designed into offshore platforms. H. E. Denzler. *World Oil*, June 1961, **152** (7), 131.—Studies of wave force and core data from the sea floor have led to improvements in the design of offshore drilling platforms, especially in the foundation work, where fewer piles are now needed. Design of platforms must consider elemental forces, foundation conditions, and construction methods. Each of these factors is discussed, and it is shown that minimum surface area should be exposed to wave forces, so reducing horizontal loading on the structure when affected by wave action. *Ca* 1000 fixed platforms have now been erected in the Gulf of Mexico, and none of these have failed in storms. C. A. F.

1324. The criterion of density of solids in controlling heavy muds: applications at Lacq. (In French.) M. Labouyasse, A. Garcia, and A. Nicolau. *Bull. Ass. franç. Tech. Pétrole*, Nov 1960, (144), 953–66.—The Lacq gas with 16% H_2S and 9·5% CO_2 is dangerous to mud and steel; the pressure is 650 kg/cm² at 3500 m, and the temp 130° C at 4000 m. 13¾-, 9⅝-, and 7-inch casing is used. Mud density of 1·5–2·3 is needed. A high lime mud helps in drilling marls and anhydrite; a low lime mud is best at depth in the presence of gas. Chemicals afford good control when mineral colloids are in the appropriate amounts, which seem to depend on the density. Various tests are possible. The API dist method involves heating 10 cc of mud electrically in a steel cyl, and the liq is collected in a measuring cyl reading to 0·1 cc. It is subject to various errors, and in a modification 100 cc is used, giving better results.

By careful control of the density of the solids in mud, the cost of muds has been reduced and operations have been safer. Treatment is possible by dilution and centrifuging, rather than by expensive chemicals. G. D. H.

PRODUCTION

1325. Contribution to the methods of study of porous media. (In French.) A. Thomas, P. Alba, and G. Couraud. *Rev. Inst. franç. Pétrole*, 1961, **16**, 36–47.—Semi-permeable disks for capillary pressure studies have been investigated. Sintered alumina disks were obtained with displacement pressures of 10–12 kg/cm². Hasseler's pneumatic system was used to keep plug and disk in contact. In several runs it was found that specimens had not attained the irreducible minimum water

saturation at 10 kg/cm². Many published curves do not go beyond 3–5 kg/cm², with the possibility that the saturation error may be 5%. A single curve may take two months to obtain, with six days allowed per step, when using a semi-permeable disk.

Plots of permeability against porosity with contouring in terms of frequency, density, and formation factor were made, and it was concluded that short-cut methods were not practicable; direct measurements rather than correlations are necessary.

Fluid contacts can be found via neutron logs for gas/oil, and by means of the capillary pressure curve and water saturation estimated from electric logs for oil/water.

Correlations have been examined for various wells and areas involving permeability and irreducible saturation, permeability and the pressure corresponding to the intersection of lines representing the main sections of capillary pressure curves (mercury injection), natural radioactivity and the difference between neutron and core porosities, irreducible saturation, and saturation derived from logs. G. D. H.

1326. Study of the interfacial tension of oil by the method of deformation of pendant drops. (In French.) R. Merigoux and M. Taxy. *Rev. Inst. franç. Pétrole*, 1961, **16**, 150–60.—For a pendant droplet of oil in water $\gamma = S\sigma(d_e)^2H^{-1}$, where σ is the density difference of the two fluids, d_e is the max dia, and $S = d_s/d_e$, d_s being the dia at a height d_e above the bottom of the drop. H is a function of S, obtainable from tables. The drops are enlarged by moving a piston. Their form is recorded photographically. The first photograph can be taken after 6–8 sec. Each of four oils showed a marked drop in interfacial tension with increase in age of the surface. In three cases the minimum value was attained in under 2500 sec.

In further experiments, after allowing the interface to evolve normally for a certain time the piston was retracted slightly, contracting the drop surface area, packing the polar molecules. This gave a sharp drop in interfacial tension, but in two cases this was followed by a temporary rise before following the previous general trend. The El Gassi oil showed a continued sharp drop in interfacial tension before the curve flattened.
G. D. H.

1327. High density packer fluids pay off in South Louisiana. C. M. Hudgins, R. L. McGlasson, and E. D. Gould. *World Oil*, June 1961, **152** (7), 113.—High density brines with weights up to 14 ppg have been used successfully as packer and completion fluids in offshore S Louisiana, where sand production is a major problem. They have two main advantages over conventional drilling muds: (1) the use of a clean, solids-free medium minimizes formation damage, and (2) fluids do not settle or solidify in the tubing–casing annulus and so complicate workovers. It has been found in the area that conventional muds interfere with plastic squeezes. Details of the fluids are given with costs; three basic systems are suitable for completions of packer fluids: (1) NaCl—8·3–9·8 ppg, (2) $CaCl_2$—8·3–11·5 ppg, and (3) $CaCl_2$–$ZnCl_2$—11·5–14·0 ppg. The use of each is described in detail. C. A. F.

1328. Some practical applications of fluid mechanics in oil production. (In French.) J. P. Verrien and G. Aufrere. *Rev. Inst. franç. Pétrole*, 1961, **16**, 48–57.—A relationship involving permeability can be derived for the pressure build-up on closing in. The ideal behaviour is sometimes modified by a skin effect, or by the existence of a permeability barrier near the well. The productivity index is also important, together with the static pressure, the skin effect, and the permeability in the drainage area.

The procedure adopted in testing a well at Zarzaitine is described, together with the calculation of the static pressure, permeability, skin effect, and productivity index. There is also a calculation on Edjeleh No. 108, which has an anomaly attributable to a fault or permeability barrier nearby.

Studies on more than 150 wells have indicated numerous instances of formation damage, and a few cases of increased permeability near the well, evidently due to fractures created during drilling.

The build-up for a gas reservoir showed two straight segments on a conventional plot, the ratio of the slopes being approx the ratio of the visc of gas and water. The gas vol derived agreed well with that obtained from geological data.
G. D. H.

1329. Electrodeless system for measuring electric logging parameters on cores and mud samples. I. Fatt. *J. Petrol. Tech.*, 1961, **13**, 292–4.—The use of devices with electrodes for measuring the resistivity of muds and cores involves various problems. The apparatus employed has the solution under study as a loop coupling two transformer coils. A fixed ac voltage across one coil causes a voltage to appear in the other coil, this voltage being a function of the resistance of the liq-filled loop. The frequency is 18,000 cps and temp compensation gives readings adjusted to 25° C. A plastic-mounted cyl core can be substituted for part of the liq loop. A modified Hassler-type sleeve could be substituted for the plastic coat. On test with mud circulation the apparatus was checked against two- and four-electrode cell measurements. Agreement was within ±2% of the four-electrode cell data; except for a mud with emulsified oil there was good agreement with two-electrode data. Formation factors from electrodeless measurements agreed closely with two- and four-electrode measurements. G. D. H.

1330. Fractures and craters produced in sandstone by high velocity projectiles. J. S. Rinehart and W. C. Maurer. *J. Petrol. Tech.*, 1961, **13**, 273–6.—Many experimental studies have been made to determine the mechanics of crater formation and the forces coming into play when a projectile strikes rock. The new work used spheres of dia $\frac{1}{16}$, $\frac{3}{32}$, and $\frac{7}{16}$ inch, with impact velocities of 300–7000 ft/sec. The craters have a cyl hole (burrow) of the sphere dia, and a wide cup at the surface. Material from the burrow is crushed and pushed aside as a high-density zone. Fractures initiated in front of the projectile propagate along logarithmic spirals to the free surface to give the cup, and below its base is a group of similar fractures a few mm apart which do not reach the surface. Penetration is proportional to the mass of the projectile, to a material constant of the target material, to the difference between the impact velocity and the minimum velocity for cratering, and inversely to the projected cross-sectional area of the projectile. The material constant correlates closely with the shear strength of the rocks, and seems to be inversely proportional to their specific acoustic resistance, the proportionality factor depending on the shape of the projectile.
G. D. H.

1331. Use of sidewall core analysis in formation evaluation. E. H. Koepf and R. J. Granberry. *J. Petrol. Tech.*, 1961, **13**, 419–24.—Currently sidewall cores can be obtained if needed in moderately dense rocks and in somewhat larger sizes than the early ¾-inch dia and 1½-inch length. Scaled-down analytical techniques have been developed. Sidewall coring is a valuable exploratory tool, and can give qualitative information obtainable in no other way after the formation has been penetrated. The measured porosity on sidewall cores may be too high, especially in dense rocks; the measured permeabilities of Gulf Coast sands tend to be too high for sand with permeability less than 20 mD, and too low for sands over 20 mD. Compaction and shattering appear to be the cause of these results. Sidewall cores are flushed more than conventional cores, because scraping action may have removed the filter cake from the well walls several times. Mud solids can invade to a depth of 2–3 cm. Contamination by oil from drilling muds is also possible. Frequency of sidewall sampling is important; one sample/ft is the minimum. At least one

sample should be below an indicated oil/water contact. Accurate depths are important.

Sidewall samples verify lithology and aid in calibrating electric log readings. They should be considered in conjunction with logs.

A number of examples of the use of sidewall core data are described. G. D. H.

1332. Future outlook for tertiary recovery. I. P. Roebuck. *J. Petrol. Tech.*, 1961, **13**, 416–18.—In 1958 unitized fluid injection projects gave 15% of the U.S. output, and it has recently been predicted that conventional gas- and water-injection operations will give an additional $14{\cdot}8 \times 10^9$ brl of oil in the U.S.A. These operations, together with primary production, will give under one-third of the oil originally present in the currently developed reservoirs. With miscible displacement and *in situ* combustion the recovery will be less than half of the oil. Tertiary recovery is the phase following secondary recovery or pressure maintenance.

The average cost of newly drilled oil reserves in the U.S.A. was \$0.71/brl in 1950, \$1.33 in 1957, and \$1.06 in 1959. The average cost of finding new reserves was \$2.77/brl in 1959. The average price of oil was \$2.51/brl in 1950, \$3.09 in 1957, and \$2.92 in 1959. In 1959 average domestic costs were \$3.91/brl (\$1.07 exploration, \$1.21 development, \$0.91 lifting and overheads).

Of $328{\cdot}4 \times 10^9$ brl in place it is estimated that $152{\cdot}4 \times 10^9$ brl will be produced, including 44×10^9 brl by miscible drive and *in situ* combustion. The next 20 years' requirements are placed at 100×10^9 brl.

Cost, sweep efficiency, and vertical conformance efficiency limit miscible displacement and *in situ* combustion recoveries; some reservoirs are not suitable for these techniques. Carbonated water floods have been tried, and it has been concluded that residual oil was 11·4% compared with 21·4% for conventional flooding. Mining and atomic energy may be used to increase recovery. G. D. H.

1333. Perforating high-temperature wells. W. T. Bell and G. A. Auberlinder. *J. Petrol. Tech.*, 1961, **13**, 211–16.—Lab tests indicate that high mud pressure does not adversely affect charge performance in most designs of shaped-charge guns, but the producing capacity of the perforation may be reduced if the well bore pressure is well above formation pressure. High temp will call for special explosives. Max reading thermometers may give erroneously high readings at high pressures. Time as well as temp is important in thermal stability. In view of diminishing use of bullet perforators, there is reduced incentive to develop new high-temp bullet propellant powders. Cyclonite used in shaped charges seems to reach an advanced stage of decomposition if heated to 350° F. Lab tests indicate that if the blasting cap is protected the conventional explosive could be operated at 350° F for longer periods: there was consistent failure with standard equipment at 390° F. If the detonator is protected, self-detonation can originate only with the charge, but there will be no tendency to form jets. A new explosive package will withstand 430° F for one hour; the detonator must be protected above 400° F. Penetration is *ca* 11% less than with cyclonite, and the cost is five times higher for explosive. G. D. H.

1334. Reduction of friction loss on fracturing operations. R. S. Ousterhout and C. D. Hall. *J. Petrol. Tech.*, 1961, **13**, 217–22.—Tests made on 1000-ft lengths of 2-inch and 2½-inch pipe showed lower pressure drops for given rates of flow than for water when natural or synthetic polymer was dissolved in water; similarly, oil which was gelled with soap showed a lower pressure drop than oil alone, and a polymer soln with sand flowed more easily than water. Evidently pseudoplasticity helps to suppress the full degree of turbulence shown by Newtonian fluids, thereby reducing pressure loss.

Several hundred fracture treatments have been done successfully with friction-loss reducing chemical additives. Surface pressures have been notably decreased, and higher injection rates have been possible without increased hp. It has also been possible to complete wells with 2⅞-inch casing instead of 4½-inch casing, and attain injection rates of 23–28 brl/min. G. D. H.

1335. Identification, classification, and prediction of reservoir non-uniformities affecting production operations. C. A. Hutchinson, C. F. Dodge, and T. L. Polasek. *J. Petrol. Tech.*, 1961, **13**, 223–30.—Several Cretaceous sandstone outcrops in the Four Corners area and the Woodbine outcrop near Dallas have been studied with a view to developing a means of predicting the size, shape, and permeability contrast of reservoir non-uniformities. The non-uniformities depend on the depositional environment, and on the rock texture and cement content. When the cement content is not sufficient to control the permeability there are no marked changes in permeability, and the ratio of max to minimum permeabilities measured on core plugs may not exceed 5 : 1; when there is cement control the ratio may exceed 100 : 1, the cement possibly exceeding 25% of the original pore vol. Thin section studies show that porosity reduction by pressure-solution is greater for fine- than for coarse-grained sandstone under the same pressure.

Clean shale sections tend to be continuous over great distances; sandy shale sections will be fairly continuous in ripple-marked and horizontally layered sandstones, but they will tend to be discontinuous in cross-bedded sandstones. G. D. H.

1336. Significance of particle shape in formation resistivity factor-porosity relationships. E. R. Atkins and G. H. Smith. *J. Petrol. Tech.*, 1961, **13**, 285–91.—$F = R_o/R_w$ and $F = \phi^{-m}$, where F is formation resistivity factor and ϕ porosity as a fraction, can be applied to slurries as well as to rocks. Resistivity measurements on slurries and the water phase were made using a dip cell and 1000-cycle impedance bridge with an oscilloscope as null detector. Kaolinite and Ca and Na montmorillonite were used in slurries in NaCl soln, with the clay up to 10% by weight. Log–log plots of porosity against formation factor gave lines of different slopes for different minerals and for sand packs. The value of m is greater for platy than for rounded particles.

By considering a system made up of particles of two different shapes of solid, the connexion between relationships of the form $1/F = \phi^m$ and $1/F = a\phi^m$ can be obtained. The latter will apply to sands containing clays, but it can be used only when a and m have been established for the given system. G. D. H.

1337. Economic optimization of a development programme for a low-permeability reservoir. R. N. Hodgson, G. C. Clark, and M. D. Rowe. *J. Petrol. Tech.*, 1961, **13**, 231–5.—The Sacatosa field, Texas, is a marginal reserve field. Three wells were drilled in 1957. One gave no more than 8 bd after nitroglycerine shooting; one was given a single fracture treatment, and the third a dual-plane treatment. These gave bottom-hole pressures after producing 10,000 brl at an average of 18 bd. Six wells were completed in 1958, being fractured and put on uninterrupted production for a short period to give early rates, and GOR as a function of fracture size. These provided data which, together with reservoir and fluid data, served for a computer study. Runs were made for a variety of reservoir thicknesses, well spacings, and fracture sizes. Nine trials were required to simulate the field, and then 40 runs were made altering the variables. Decline curves and gas/oil ratios were obtained. Above certain small values fracture capacity and length do not appear to affect recovery significantly, but they reduce the time to reach minimum economic

producing rates, thereby affecting economics. Well spacing does not seem to affect ultimate recovery for the same minimum economic producing rate. The economic model included state allowables as well as other factors. For optimum rate of return there is a large fracture size range, but treatment costs rise sharply above 70,000 gal of fracture fluid.

A risk analysis was also made. The economics favour 40-acre spacing. G. D. H.

1338. Which shows faster payout, platforms or ocean floor completions? C. M. Shields and A. J. Field. *World Oil*, June 1961, **152** (7), 91.—Engineering and economic aspects of underwater completions are discussed. There has been increased interest recently in the ocean floor completion due to the high cost of multi-well platforms. In locating well heads under the sea it is also possible to minimize corrosion and sea growths and reduce the hazard due to collision by ships and damage by wave action. Artificial lift can be carried out by gas lift and hydraulic pumping as in exposed wells, and maintenance and workovers could be made with smaller pulling rigs. The submarine completion could have a shorter or longer life than platform wells, and ocean floor completions are not necessarily more economical than the platform type in shallow water. C. A. F.

1339. New concentric tubing workover rig cuts remedial costs offshore. R. W. Scott. *World Oil*, June 1961, **152** (7), 102.—A new concentric tubing workover rig has been operated in offshore Louisiana in order to cut costs on small well protector type platforms. The unit can operate continuously and fits platforms down to 15 ft by 20 ft in size. It is fitted with double drum draw-works, hydraulic rotary table, twin diesel engines, triplex plunger pump, and mud fittings. It can operate as a single- or twin-engine unit and has a removable mast which can handle singles and doubles. Details of the unit are given with diagrams and photographs. It has operated successfully, and three wells have been worked over on three separate localities within one 24-hr period. C. A. F.

1340. How to operate offshore production by remote control. S. H. Miller and A. C. Bradham. *World Oil*, June 1961, **152** (7), 107.—A new fully automatic control and data telemetering system has been installed for three high-pressure gas condensate wells near Mustang Island in the Gulf of Mexico. There is provision for control function, measurement of production variables, alarms and monitoring, and platform security. Details of the installation are given with flow diagrams. All functions and data are transmitted through a submarine cable between the offshore platform and the onshore control station. Basic functions of the automation system are: (1) valve control to stop and start each producing well; (2) adjustable choke to regulate flow rate; (3) temp control of the production unit; and (4) operation of corrosion inhibitor injection pump. The system has given a net saving of $4852/month, compared with manned operations. C. A. F.

1341. West German petroleum and natural gas exploration in 1959. (In German.) D. Malzahn. *Erdöl u. Kohle*, 1960, **13**, 231–35.—Compared with 1958 the number of exploration wells and metrage drilled in 1959 was somewhat smaller. This was directed chiefly to further opening of structures not yet drilled, in the separate provinces, or to following further promising objects in the vicinity of oil- or gas-producing structures. The centre of drilling activity lies in NW Germany, chiefly for oil-bearing structures, on the edges of the pre-Cretaceous syncline. Several drillings were started in the Pompeian fault block, but were uneconomical. At the end of the report year, in the Federal Republic 97 oilfields (end of 1958, 85) and 23 gas fields (16 in 1958) were producing. 14 gas fields have not taken up regular production. R. T.

OILFIELD DEVELOPMENT

1342. In elongated anticlinal reservoirs, horizontal fractures do affect ultimate recovery. B. L. Landrum and P. B. Crawford. *Petrol. Engr*, June 1961, **33** (6), B80.—A reservoir analogue study is reported. The assumptions made in this model study are clearly outlined. The effect of well position and fracture size on flood pattern, sweep efficiency, etc., is reported, and the results are discussed in detail. The effect of fracture size on sweep efficiency varies with the position of the well in the anticlinal reservoir, but can be quite important. G. D. F.

1343. What's the free world offshore oil and gas outlook? Anon. *World Oil*, June 1961, **152** (7), 79.—Oil and gas development offshore is increasing in importance, and there have been notable technical advances in recent years. Marine geophysical methods now provide improved and faster coverage offshore than onshore, and oceanographical research provides data assisting the interpretation of subsurface formations. Drilling activity in the U.S. Gulf Coast is greater than a year ago, and there is active geophysical exploration. There have been recent gas finds which are listed. Important offshore oil and gas fields are reported from California. Offshore operations in other areas are briefly described, including Canada, Mexico, Trinidad, Venezuela, W coast of S America, and the Magellan Straits. In the E Hemisphere offshore operations are also being carried out in the Mediterranean, Persian Gulf, and Japan. Future prospects for offshore development are good, in spite of the high cost of operations. Efficient geophysical tools now enable offshore structures to be located fairly easily. The recent find of indigenous Pleistocene oil in the Gulf of Mexico will stimulate the search for similar production in such features as drowned river deltas. 13 refs. C. A. F.

1344. Reserves may spell success for the Panhandle. B. E. Bardy. *Oil Gas J.*, 5.6.61, **59** (23), 128.—Delays in FPC rulings, joint operation of producing leases, and other factors have led to a shut in of over 300 gas wells in the Panhandle of Texas and Oklahoma, and this may cause internal reservoir damage by drainage. Nevertheless, the area holds immense reserves of gas, and there are 2600 producing wells. Accurate reserves prediction for the area are critical, and it is not possible to apply an acre-ft recovery factor to each pay zone. Vol reserve calculations can be misleading, but on production accurate data can be obtained from pressure declines. Examples of pressure–production curves are given for four pays: Council Grove, Hoover, Tonkawa, and Chester. These are analysed, and they show a great variation in reserves from wells in the same field. Future of gas production in the Panhandle will be determined by prices allowed by FPC, and unless a high enough price is quoted many areas capable of producing 500 million to 1 billion cu ft will never be developed. Three refs. C. A. F.

1345. Washington, Oregon having active exploration year. R. J. Deacon. *Oil Gas J.*, 5.6.61, **59** (23), 135.—There is active exploration in Washington and Oregon, where main interest is in offshore possibilities. Sparker surveys are being carried out off Coos Bay and surface mapping in upland areas. Several areas are planned for drilling, particularly in the Williamette Valley of W Oregon. To date oil production has only been found in the Ocean City area of Washington, but this was small, and several unsuccessful wells have been drilled. C. A. F.

1346. Developments in Eastern Canada in 1960. D. Jardine *et al. Bull. Amer. Ass. Petrol. Geol.*, 1961, **45**, 986–92.—Although the number of exploratory wells in Ontario showed a decrease in 1960 as compared with 1959, the trend towards deeper drilling results in only a modest change in drilled footage; 183,000 ft in 1960 compared with 193,000 ft in 1959.

Development footage was up slightly at 201,400 ft for 1960, as opposed to 197,000 ft in 1959, so that the total number of wells drilled and total footage drilled remained relatively constant over the two years.

Acreage held decreased significantly in almost all areas, and field-party activity, both geological and geophysical, decreased by approx 50%. E. N. T.

1347. Developments in Western Canada in 1960. T. J. Latus. *Bull. Amer. Ass. Petrol. Geol.*, 1961, **45**, 974–85.—This report reviews exploration and development activities in W Canada during 1960, and shows an overall decline, although expenditures are estimated to have decreased only slightly owing to deeper, more costly drilling, and increased exploration drilling in the remote N regions.

There was a slight decrease in the overall number of wells drilled from 2551 to 2516. Exploratory tests declined 13% to 818. Success of exploratory drilling remained at 30%, and gas discoveries again exceeded oil discoveries. The NW Territories recorded its first gas discovery, and other important gas finds were made in the foothills of the Rocky Mountains and NE British Columbia. There was a marked increase in exploration activity in the N regions, and a severe decline in Saskatchewan. Geophysical work continued to decline, and surface mapping also declined for the first time.

Crude oil production reached a new high of 192 million brl, and natural gas production also reached a new peak at approx 583 billion cu ft. Land holdings decreased by *ca* 4% to 256 million acres. E. N. T.

1348. Manitoba oil crop may be withering on the vine. Anon. *Oil Gas J.*, 5.6.61, **59** (23), 127.—After initial development success in Manitoba from 1951 until *ca* 1955 there have been many failures, and heavy withdrawal of reserves are now required to sustain production. Exploration is now at a minimum, only 13 wildcats being drilled in 1960 and only three finding a little oil. Prospects for revival are poor, and there is no large natural gas bonus to encourage exploration. Most of the production of the state comes from Virden–Roselea, N Virden–Roselea, and Daly. A chart shows production, development, and reserves history for Manitoba from 1951 to 1960. C. A. F.

1349. Developments in Alaska in 1960. D. D. Bruce. *Bull. Amer. Ass. Petrol. Geol.*, 1961, **45**, 993–8.—During 1960 exploratory and development drilling operations increased considerably, while surface mapping and geophysical activities showed a substantial decrease. 31 wells were active during 1960, compared with 20 in 1959.

18 oil companies had surface parties in the field during the year. At the close of the year there were approx 34,000,000 acres under Federal oil and gas leases and 117,203 under State of Alaska oil and gas leases. E. N. T.

TRANSPORT AND STORAGE

1350. Study and prediction of pressure variations in the operation of subsurface gas storage reservoirs. (In French.) L. Richard and P. Chaumet. *Rev. Inst. franç. Pétrole*, 1961, **16**, 58–64.—Relationships have been obtained for pressure build-up in a well, in an infinite aquifer, a closed aquifer, and for one with a constant feed. All the curves start in the same way and then diverge. By graphical means the type of aquifer may be determined. Evidence on its properties is also obtained.

For a thin storage horizon and a gas bubble of reasonable size the flow will be parallel with the bedding, sub-horizontal and radial. Past production history can give the diffusivity for the equivalent circular aquifer, and also the external radius of this if the data are sufficiently extensive. It is also possible to compute gas outputs.

By the above steps the properties of the Beynes storage aquifer have been obtained. Injection and withdrawal rates have been obtained for various pressures. Plots show observed and predicted pressures, and injection and withdrawal rates. The calculations are relatively tedious, and a hydraulic analogue is therefore being studied. G. D. H.

1351. Estimation of storage costs and rates of evaporation of liquefied gases (methane, ethane, ethylene, and propylene) in underground cavities. (In French.) P. B. Crawford. *Rev. Inst. franç. Pétrole*, 1961, **16**, 65–78.—Liquefaction of methane and transport by ship would permit gas from various areas to be used in other parts of the world, and for meeting extra winter demands. A pipeline not operating at full capacity represents immobilized capital. Storage of liquefied methane was started on a small scale *ca* 30 years ago at Cleveland, Ohio. This had a capacity of 150×10^6 cu ft of gas, and provided data which after the war were used to design a liquefaction plant for $4{\cdot}5 \times 10^6$ cu ft/day. The Cleveland storage was in spheres of 57 ft dia with 3 ft of insulating material. The Canvey Island reservoirs were of different design. Surface storage is costly, and may be *ca* \$6.5/cu ft of liq methane.

Underground storage of liq methane has been considered, and the evolution of the temp distribution around a spherical cavity has been calculated. High temp gradients are indicated. The rate of evaporation of methane has also been computed; this decreases as the rock is cooled, and is 1–0·1%/day, dependent on cavity size, time, pressure, etc.

The storage of liq ethane, ethylene, and propylene has also been considered. At 150 psi, propane and butane can be stored in liq form without cooling. Storage at 400 psi will reduce the evaporation rate for methane by 35% and for ethane by 85%, as compared with storage at atm pressure. Evaporation of methane in production can be used for refrigeration or power generation via a turbine which would give 50,000 KWH/10^9 cu ft/day. Subterranean storage would be safer than surface storage, and the cost might be \$0.75–1.75/cu ft of space, depending on size and conditions.

Curves and tables summarize the results of various calculations. G. D. H.

1352. Oil tanker ss *Serenia*. Anon. *Engineer, Lond.*, 1961, **212**, 157–8.—Description of new 66,000-ton dwt (42,000 gross), 16·5-knot tanker for Shell. H. K.

1353. Weymouth gas flow formula has limitations. R. H. Parekh. *Petrol. Engr*, June 1961, **33** (6), D51.—It is shown that the Weymouth formula frequently used for the calculation of gas flow in pipelines is applicable to only one value of the friction factor. The Reynolds number corresponding to this value for various pipe sizes is calculated. For other Re, corrections are necessary for exact results. G. D. F.

1354. Pipelines in relation to other forms of transport. M. E. Hubbard. *Fluid Handl.*, 1961, 92–4.—Abstract of paper presented at Pipeline Industries Guild symposium on economics of pipelines. Principles involved in pipeline transport are considered, with brief reference to tanker, river, and rail transport of oil. W. A. M.

1355. Pipelines in the oil industry. J. D. Graham. *Chem. Proc. Engng*, 1961, **42**, 199–202.—Economic aspects of oil pipelines are briefly surveyed; costs of 8- and 10-inch lines are compared for different throughputs. Technique of using pipeline to convey different products is described. W. A. M.

1356. A thin route beyond the horizon—VHF system in Middle East. J. D. Hoffman. *Pipe Line News*, April 1961, **33** (4), 22.—The 30-inch crude oil pipeline of the Trans-Arabian Pipe Line Co, which crosses the N parts of Saudi Arabia and Jordan and the S parts of Syria and Lebanon, is remote-controlled and telemetered by 160-mc VHF systems. The major elements of design are: (1) acceptance of relatively low median voice channel to noise and crosstalk ratios; (2) use of frequency diversity in preference to space diversity; (3) use of relatively low cost 160-mc radio equipment; (4) use of a single large antenna for each direction along the pipeline; and (5) use of compandors on the voice channels.

The paper gives detailed description of the choice of station site, towers and transmission lines used, relay and remote control circuits and equipment, and the economic factors involved. M. F. M.

REFINERY OPERATIONS

REFINERIES AND AUXILIARY REFINERY PLANT

1357. Continuous in-line blending systems. R. L. Botting. *Chem. Proc. Engng*, 1961, **42**, 259–61.—A continuous in-line blending system for fuel oils is described and illustrated; differential pressure across a diaphragm between the two streams actuates balancing valves. Errors on commercial units are within $\pm 1\%$ without individual calibration. W. A. M.

1358. Refinery instrumentation—a new installation guide by the American Petroleum Institute. R. R. Proctor. *Proc. Amer. Petrol. Inst.*, 1959, **39** (3), 128–9.—This paper announces the forthcoming publication by the API of a manual of recommended practices for the installation of instruments in petroleum refineries—the work of the Sub-Cttee on Instruments of the API Cttee on Refinery Equipment. The paper gives a brief history of the development of the manual and a résumé of its contents. The manual is intended to serve as a guide for the installation of the generally used measuring and controlling instruments and related accessories in order to achieve safe, continuous, accurate, and efficient operation with minimum maintenance. The purpose of the paper is to call refiners' attention to the manual, which will be published sometime during late 1959 or early 1960. (Author's abstract.)

1359. Heat and flow investigations on finned tube bundles subject to transverse flow. 2. Effect of fins and tube arrangement. (In German.) H. Brauer. *Chem. Ing. Tech.*, 1961, **33**, 431–42.—The results of investigations on the effects of different fin heights and fin spacings on the heat transfer coeff are presented. Experiments have also been carried out on the effect of the number of rows of tubes on flow resistance and heat transfer coeff. G. D. F.

1360. Guiding refinery operations with small semi-automatic pilot plants. W. M. Miller. *Proc. Amer. Petrol. Inst.*, 1959, **39** (3), 222–8.—Data from small semi-automatic pilot plants, which are reasonably inexpensive to run and which correlate closely under carefully controlled conditions with actual commercial results, provide a valuable source of accurate information for guiding refinery operations. Examples are shown of how data from small cat cracking, hydrosulphurizing, reforming, and fluid coking pilot plants are used in a number of ways to plan the operation of Tidewater Oil Co's Avon and Delaware refineries. Mention is made of the use of pilot-plant data in the Avon and Delaware refinery simulation programmes using IBM 650 electronic data computers. A description of the pilot plants used to furnish these data points out their small size, as well as their automatic and safety features. Two of these units are believed unique in the oil industry in that they are run unattended 16 hours a day. This reduces operating costs and eliminates shift work. (Author's abstract.)

1361. New developments and techniques in delayed coking. V. Mekler and M. E. Brooks. *Proc. Amer. Petrol. Inst.*, 1959, **39** (3), 229–45.—The coking process remains the most important process in reducing the production of residual oils, and the renewed activity of the delayed coking process indicates the role it will continue to play in the economics of refinery operation. It is predicted that, during the next seven years, additional coking capacity, equivalent to approx 75% of the total present capacity, with a production of approx 11,000 tons/day of coke, will be built in the U.S.A. This paper also discusses process variables and their effect on the design, performance, on-stream time efficiency, and economics of the delayed coking units. It also gives curves for establishing product yields from coking. It describes technological development in the design and operation of the critical equipment, such as coking heaters, coke drums, coke handling equipment, etc., and shows how attention to detail in the design and operation of critical equipment has permitted delayed coking to process heavy petroleum and non-petroleum residual oils with Conradson carbon of over 40% by wt, while at the same time improving the length of run and on-stream time efficiency. The paper also presents an economic evaluation of a 10,000-bd delayed coking unit producing 450 tons/day of coke. This evaluation shows the pay-out period of different values of charging stocks and products. (Author's abstract.)

1362. Turba-film processing for petrochemicals. A. E. Williams. *Petroleum, Lond.*, 1961, **24**, 228.—A type of thin swept-film evaporator has been installed in a U.S. refinery for the processing of highly viscous products such as sulphonate additives. The processing technique is outlined, and the adaptability, ease of operation, and savings over the previous batch methods of processing are described. G. D. F.

1363. Manufacture and use of filters in the petroleum industry. (In French.) — Delage. *Bull. Ass. franç. Tech. Pétrole*, 1961, 115–26.—Lecture, with especial reference to two types of proprietary filter, for particles down to 5 μ and 0·1 μ; latter can have capacity up to 320 m³/hr, main use is for jet fuels. V. B.

1364. Pressure-energized high pressure gaskets. Application to petroleum production equipment. A. F. Rhodes and R. Eichenberg. *Fluid Handl.*, 1961, 135–7.—Abstract of paper presented at British Hydrodynamics Research Association conference on fluid sealing. Pressure-energized steel ring gaskets to API and ASA specifications are described and illustrated. These gaskets do not depend on bolt load for sealing and enable smaller flanges to be used at high pressures (up to 15,000 psi). W. A. M.

1365. Chemical plant repairs using epoxy and polyester resins. H. Hughes and A. F. Hall. *Engineer, Lond.*, 1961, **212**, 137–41.—Description of resins and their mechanical and chem properties; applications include repairing leaks in base of mild steel oil storage tanks. H. K.

DISTILLATION

1366. Distillation in view of modern developments. Pt 2, Chap 2g. Theory of fractionation—complex distillation. K. F. Gordon and J. A. Davies. *Petrol. Engr*, June 1961, **33** (6), C41.—Three methods are described for solving dist problems involving complex mixtures (*i.e.* mixtures of so many components that the individual components cannot be

separated by ordinary dist methods). These methods are: (1) the componential method, approximating the complex charge by a charge composed of fictitious components; (2) an empirical method, involving the use of TBP or ASTM curves, heat and mass balances; (3) an integral method, which is tedious and seldom used. Examples of the use of methods (1) and (2) are given. G. D. F.

CRACKING

1367. Orthoflow C catalytic cracking. C. E. Slyngstad and P. T. A. Heridg. *Oil Gas J.*, 15.5.61, **59** (20), 146–51.—The Orthoflow C cat cracking unit incorporates all the improvements of the earlier models and gives significantly improved product distribution and operational flexibility. The advantages of the new design are discussed in terms of an idealized reactor, stripper, and regenerator for fluid cracking.

The new design, incorporating high regenerator temp and comparatively low cat-to-oil ratios, minimizes the amount of unstripped hydrocarbons carried to the regenerator. Furthermore, cascading hot spent cat to the bed reduces the opportunity for subsequent cracking of heavy hydrocarbons absorbed on the cat surface. The chief attraction of this equipment is the improved product distribution when it is used for gas-oil cracking. Improvement stems from three features—use of an optimum temp transfer line for fresh feed conversion; rapid separation of cat from transfer-line effluent; and cycle-oil cracking under more severe conditions than those imposed on virgin feed. A. D. S.

1368. Acid catalysts and their use in hydrocarbon conversion. (In French.) Y. Trambouze. *Bull. Ass. franç. Tech. Pétrole*, 1961, 59–72.—Main theories of mechanism of heterogeneous catalysis considered, with special reference to acid heterogeneous catalysis, leading to concept of acidity of insoluble solids, *i.e.* " insulator " cat whose active portions are oxides or oxide mixtures. This type of acid cat is frequently employed in the petroleum industry. Reaction mechanisms of hydrocarbon conversions (cracking, isomerization, polymerization, alkylation) discussed. (Author's summary.)

ALKYLATION

1369. Expansion of sulphuric acid alkylation for motor fuel production. A. R. Goldsby and D. K. Beavon. *Proc. Amer. Petrol. Inst.*, 1959, **39** (3), 254–61.—The expansion of four different alkylation units employing a sulphuric acid cat is described. Each of the units involves a different problem, but none required the addition of any major fractionation equipment. As a result, the increases in capacity were obtained at lower cost than if new units had been installed. In all cases additional refrigeration was required. A closed-cycle, propane-refrigerated unit utilized for the alkylation of butylenes and amylenes was expanded to give *ca* 50% increase in capacity from a mixed propylene–butylene feed by converting it to effluent refrigeration. Two closed-cycle, propane-refrigerated butylene units with common fractionation facilities were expanded by adding effluent refrigeration to one unit for operation on butylenes, and keeping the other unit on propane refrigeration for mixed propylene–butylene alkylation. The increase in capacity was *ca* 50%. A cascade auto-refrigerated unit with a capacity of 2185 bd was expanded by approx 70% by adding two reaction zones to the four-zone reactor. A closed-cycle butylene unit was expanded almost five-fold by converting it to cascade auto-refrigeration and replacing the closed-cycle reactors with cascade auto-refrigerated reactors. (Author's abstract.)

CHEMICAL AND PHYSICAL REFINING

1370. New process for determining the theoretical plate number of a packed column. (In German.) E. Terres and W. Meyer. *Erdöl u. Kohle*, 1960, **13**, 266–8.—Estimation of the theoretical number of plates, or the number of steps necessary for a theoretically required concn in the low-boiling range, can be performed by graphical methods or by the step process. In the latter the following eqn are taken as the basis for calculation, where n implies the number of steps fom x_B to x_B.

$$\alpha = \frac{x_B(1 - x_B)}{x_B(1 - x_B)} \qquad \text{(I)}$$

Solving for n

$$n = \frac{\log \frac{x_B(1 - x_B)}{x_B(1 - x_B)}}{\log \alpha} \qquad \text{(II)}$$

By solving eqn (I) function $\alpha^n = \frac{\text{const}}{\frac{1}{x_B} - 1}$ is obtained. Presenting this function on double logarithmic paper a host of straight lines is obtained with const x_B. By introducing a parameter, from x_B and the appropriate x_B curve the plate number can be read directly. As basic eqn for presentation in triangular co-ordinates follows:

$$\log \alpha^n = \log \left(\frac{1}{x_B} - 1\right) - \log \left(\frac{1}{x_B} - 1\right) \qquad \text{(III)}$$

By logarithmic division of all triangle sides α^n, $\frac{1}{x_B} - 1$, $\frac{1}{x_B} - 1$ can be entered directly. Determination of the theoretical plate number from the described triangle is discussed for a mixture of *n*-heptane and methyl*cyclo*hexane. R. T.

SPECIAL PROCESSES

1371. Elimination of hydrogen sulphide from industrial gases. (In French.) H. Guinot, P. Le Henaff, and X. Tinchant. *Chim. et Industr.*, 1961, **85**, 561–75.—Present procedures critically reviewed. New method described, based on aq soln of ferric propionate, which can be indefinitely regenerated; process is especially applicable when CO_2 need not be removed. (Author's summary.)

1372. Olefin production from liquid petroleum stocks. J. A. Knaus and J. Hanisian. *Proc. Amer. Petrol. Inst.*, 1959, **39** (3), 204–12.—The rapidly increasing demand for olefins as chem intermediates has centred attention on their recovery from refinery gas streams and their production from natural gas hydrocarbons. However, a significant number of olefin producers have turned to heavier liq feeds for a variety of reasons. For many years, The M. W. Kellogg Co has been marketing plants for olefin production in which naphtha or gas oil are the feedstocks. Design bases resulted from an extensive pilot-plant study employing a wide variety of liq feeds. It was found that ethylene and butadiene yields at constant conversion of feed (as measured by dry gas yield) were relatively insentitive to feed properties, but lower yields of propylene and butylenes were obtained from gas oils than from naphthas. However, operability factors dictate max conversion level, with the result that ultimate yields of olefins are somewhat lower with heavy feeds than with light. Judging the value of pyrolysis feeds using a Gulf Coast price structure, it was found that total by-product credits increased as the mol wt of the feed was increased at constant yearly ethylene production. On the basis of net credits—feed minus product values—casinghead gasoline was an extremely attractive feed, with butane and light naphtha following closely in that order. Plant size has a significant effect on overall economics, in as much as per cent return on invested capital from a 400 million lb pa light naphtha plant is three times that from a 100 million lb pa plant with only ethylene recovered as a product for sale. (Authors' abstract.)

1373. Use of the Udex process for refinery octane balancing. H. W. Grote and D. B. Broughton. *Proc. Amer. Petrol. Inst.*, 1959, **39** (3), 248–53.—The Udex process was developed originally to provide the chemical industry with an adequate supply of aromatic hydrocarbons of higher purity than those previously available. More recently it has been adapted to separate the high octane components of gasoline from those of lower quality. With this process, the refiner can separate a gasoline of medium quality into one portion consisting of high octane, premium quality gasoline components and another consisting of the lower octane materials. The lower octane portion can be handled in several ways. It can be sold directly as a high-grade jet fuel distinguished by its smokeless burning characteristics or as a solvent distinguished by its freedom from aromatic odour. Alternatively, it can be treated further by processes such as Platforming on Penex to increase its octane rating, and thus can be used in high-quality gasoline products. The Udex process provides the refiner with flexibility in adjusting the proportions of premium and regular gasolines, jet fuel, and speciality solvents in accordance with current market requirements. (Authors' abstract.)

1374. Optimal utilization of by-product hydrogen in an integrated oil refinery. G. T. Gwin. *Proc. Amer. Petrol Inst.*, 1959, **39** (3), 193–203.—The use of hydrogen treating in petroleum refining to obtain significant quality improvement at high yield, with the elimination of older finishing steps, has gained remarkable impetus in the past few years. Hydrogen treating is used under varying conditions to improve the quality of virgin and cracked naphthas, virgin and cracked domestic heating oils, kerosine, jet fuels, diesel oils, gas oils, lub oils, solvents, and paraffin wax. A recent application of interest is the improvement of gas oils for changing to cat cracking. This process can also be applied advantageously to improving the cracking properties of the heavy gas oil extractable from residuum with light hydrocarbon solvents. The subsequent yield and octane rating of the cracked gasoline are improved as a result of hydrotreating the cracking feed. In the longer range the hydrogenation process is likely to be applied to residual oils or to whole crude oil for conversion to lighter and more valuable products. The economics of hydrogen have been spurred by the availability of by-product hydrogen from cat reforming of naphthas. In general, the refiner engaged in full-scale platinum reforming of virgin naphtha will have adequate hydrogen available for hydrotreating all fractions of the crude oil. The hydrogen-treating operations currently being conducted by Humble Oil and Refining Co are described. (Author's abstract.)

1375. Electrostatic desulphurization of reformer feedstocks. R. J. Phillips and H. G. Napier. *Proc. Amer. Petrol. Inst.*, 1959, **39** (3), 262–7.—The electrostatic desulphurization process, recently tested in a full-scale commercial unit, consists of a reaction stage in which sulphuric acid of almost any concn is added directly to the feedstock, a neutralization stage in which the treated oil is mixed with weak caustic, and a water-wash stage. Electrostatic mixing is used to promote contact in the reaction stage, and electrical coalescence in all stages. Sulphur removal is as high as 95%; arsenic, lead, and nitrogen cpds are also removed. Treating losses are less than 0·5% with straight-run naphthas, but increase with increasing amounts of unsaturates and increasing mol wt of the feedstock. The installed cost of a 10,000-bd unit should not exceed $350,000. If fresh acid is used, total operating costs are estimated as $0.079/brl, but if spent alkylation acid is available, operating costs can be reduced to $0.048/brl. The process is especially suitable for the pre-treatment of reformer feedstocks. (Authors' abstract.)

1376. SBA-process for obtaining acetylene and ethylene. (In German.) F. Braconier. *Erdöl u. Kohle*, 1960, **13**, 248–51.—Means are sought to replace the expensive method of C_2H_2 production from CaC_2. CH_4 pyrolysis yields C_2H_2 diluted with other gases, necessitating a two-stage process for obtaining diluted C_2H_2 and its conen to pure gas. Calories for the reaction must be produced in the reaction itself. Required energy is produced by partial CH_4 combustion, O_2 required sufficing to bring the preheated gas to ca 1400° C. This O_2 is insufficient for a stoichiometric complete combustion. It is arranged so that two-thirds CH_4 are burnt and converted to one-third C_2H_2 and H_2. CH_4 and O_2 thoroughly mixed and strongly preheated (600° C) are ignited and the incompletely burnt gases quenched. The capacity of the industrial burner is 10–12 tons/day C_2H_2. Feeds containing also C_3-hydrocarbons, C_2H_6, C_2H_4 give good results. In processing higher than two C-atoms soot is formed and the C_2H_2 yield reduced. For processing these higher hydrocarbons a simple cracking process is used in which aliphatic hydrocarbons from C_2H_6 to naphtha and hydrocarbons with 10–15 C-atoms are processed. Large O_2 throughputs correspond to low temp in the cracking chamber, therefore, compared with C_2H_2, a max olefin yield. Small hydrocarbon throughputs, accompanied by higher temp, give, compared with C_2H_2, low or no olefins. Yields of C_2H_2 and C_2H_4 are increased by using large quantities of steam. Small quantities of steam give low yields of these gases but more residual gas, in some cases economical. This type of industrial burner is designed to produce 30 tons/day C_2H_2 and C_2H_4. Diluted C_2H_2 is enriched by solvent extraction, H_2O-free ammonia being preferred, after separating higher C_2H_2 derivatives and olefins. R. T.

METERING AND CONTROL

1377. What's new in instrumentation, measurement, and control? Anon. *Petroleum, Lond.*, 1961, **24**, 219.—Brief reviews are presented of various recent developments in the fields of instrumentation, measurement, and control, including a recorder for recording any variable expressable in terms of an electrical signal; a tanker ullage indicator system; pipeline remote control equipment; an excess electrical demand warning system; a holiday detector for the inspection of interior coatings on long pipelines; a series of pneumatic temp control and measurement instruments; a pressure-transmitting system; and a digital telemetering system. G. D. F.

1378. True mass flowmeter. R. B. Rowley. *Petroleum, Lond.*, 1961, **24**, 211.—The paper describes a newly developed true mass flowmeter. The theory of the device is dealt with. Briefly, the torque necessary to impart a certain angular momentum to the flowing stream is measured. The actual device is described, together with the associated equipment for indicating flow rate and total flow. Aircraft application of the device is mentioned in some detail, together with other uses and possible future developments. G. D. F.

1379. Process monitors save money and improve efficiency. S. F. Kapff and R. B. Jacobs. *Oil Gas J.*, 15.5.61, **59** (20), 141–5.—The application of process monitors in crude oil handling, in conversion processes, and in finishing treatment is described. In pipeline operations vapour pressure monitors prove useful when batches of crude oil must be segregated because some are spiked with butane and casinghead gasoline in the oilfields. Fl pt monitors, colorimeters, and viscometers are used to control dist of crude oils. End point monitors find extensive use in reforming, cat cracking, and aromatics production processes. With finishing treatments, mercaptan number monitors are used in sweetening operations and Rvp and dist monitors assist in blending.

For max profitability, these instruments must be carefully monitored and frequently calibrated. Simplicity of design permits simple and rapid maintenance at nominal cost.

A. D. S.

1380. Electrolytic moisture analyser measures trace water. R. C. Halter and L. M. Johnson. *Oil Gas J.*, 15.5.61, **59** (20), 127–9.—The electrolytic moisture analyser has replaced conventional lab tests as the preferred method for determining trace water in gaseous and liq process streams. It depends on the simultaneous quantitative absorption and electrolysis of water from a flowing gas stream in a cell containing two platinum electrodes surrounded by a P_2O_5 film. The water absorbed is continuously electrolysed by application of a dc potential across the electrodes. The current produced is directly related to the amount of water electrolysed and, if the flow rate is controlled, the water content of the gas stream can be determined.

Installation and maintenance of the instrument must be carefully designed and performed in order to obtain the desired result. Proper maintenance depends on the ability to recondition electrolytic cells. This instrument has been applied extensively on a variety of streams, including nitrogen, ethylene, propylene, hydrogen, and xylenes. It cannot be used on materials which either react with P_2O_5 or polymerize in the cell.

Brief mention is made of the new ir analyser, which shows promise as a convenient and sensitive method for determining moisture in liq. A. D. S.

1381. Chromatography can increase alkylation efficiency. J. H. Williams, Jr, and R. L. Wilt. *Oil Gas J.*, 15.5.61, **59** (20), 134–7.—Limited availability of *iso*butane at Gulf's Philadelphia refinery made its recovery for optimum utilization imperative. Before chromatograph installation, the alkylation unit, which controls *iso*butane recovery, had good instrumentation, which resulted in stable operation. However, lab samples around the tower usually required up to 24 hr before the results were known. Even though adjustments were made to approach optimum conditions, lab data showed that the tower was not being properly controlled.

It is now both feasible and economical to continuously analyse five streams with one chromatograph for eight common components. This installation had a pay-out of four months, based on savings in acid, better *iso*butane utilization, TEL requirements, and lab expense.

Operation on the unit has been smoother because the operators can foresee difficulties and make proper allowances to avoid any upset. Maintenance has been relatively low, in spite of analyser complexity. A. D. S.

1382. New liquid sampling valve for process chromatographs. C. J. Penther and J. W. Hickling. *Oil Gas J.*, 15.5.61, **59** (20), 130–3.—The valve consists of two mating plane surfaces and is designed so that differential volumetric expansion does not affect the fit. Two metal disks having mating surfaces polished optically flat within *ca* 1 μ/inch were used. The stationary disk provided parts and connexions for liq sample, carrier gas, and column. The rotary disk was drilled to contain the sample loop integrally and to provide the sample and carrier switching links.

This new valve has been used in several process gas chromatographs. One application resulted in a 95% confidence level of $\pm 0{\cdot}006\%$ by wt of total sample for 0·1% cumene in ethylbenzene. In another application, switching parts were added to the sampling valve and two columns were used to strip and analyse pentane and lighter hydrocarbons in a sample with a 228° C end point. The valve has also been used for vapour sampling, analysing at a once-per-minute rate. Column reflux is controlled to maintain the amount of top product in column bottoms at an optimum value. A 1-μl version of the valve has permitted use of liq sampling with small-bore packed columns. A. D. S.

1383. Getting the most from process analysers. C. M. Tyler and R. W. Serne. *Oil Gas J.*, 15.5.61, **59** (20), 123–6.—Process-analyser use and acceptance in operating plants are being enhanced by a new technique. Mobile analysers are installed in a test trailer and moved to an operating unit. There, trained personnel study analyser accuracy, reliability, and sample handling.

This technique has a number of advantages. Test sites and analysers can be carefully selected to provide answers to specific operating problems. A permanent installation is then only made when an analyser proves itself economical. Temporary installations can improve operations in those areas where permanent analysers cannot be economically justified.

The results of field evaluations are discussed. A. D. S.

1384. Automatic gauges for level measurement in deep storage tanks. S. F. Smith. *Petroleum, Lond.*, 1961, **24**, 215.—Manual systems of level measurement in large storage tanks suffer from various types of inaccuracies. Types of automatic level gauges are described: (1) float actuated; (2) float actuated with power assistance; (3) power driven electronic type. The operation and construction of a typical instrument of type (3) is given in some detail, together with information on installation and remote read-out. Temp measurements can be taken simultaneously. The accuracy of the method is discussed, and the saving in manpower and other advantages are pointed out. G. D. F.

1385. Versatile capacity measuring system for level control and stream analysis. E. N. Shawhan *et al. Proc. Amer. Petrol. Inst.*, 1959, **39** (3), 120–7.—Instruments for measuring electrical capacity can be simple, reliable, and versatile. A system is described which uses the same electronic units for a variety of applications. A rugged transmitter is mounted near the point of measurement. The remainder of the circuit with the zero and spar adjustments may be mounted in a convenient location. The system is independent of characteristics of the cable joining the two units. The system is in use in Sun Oil Co refineries for level measurement or control of hot liq, granular materials, very cold liq, and corrosive liq under difficult conditions where the absence of moving parts is advantageous. Compensation for effects of temp change is included. The same system is also used for certain stream analysis applications. It is used to measure moisture in liq hydrocarbon streams in the ppm range.

(Authors' abstract.)

1386. Meter for petrol dispensing pumps. R. G. Spalding. *Fluid Handl.*, 1961, 123–6.—Description and diagram of new meter for petrol dispensing pumps, operating on positive displacement pistons principle. There are two cyl at 120° to each other, and the crankcase acts as a hypothetical third cyl. Details of construction, including use of corrosion-resistant materials and results of corrosion and performance tests, are given. W. A. M.

PRODUCTS

CHEMISTRY AND PHYSICS

1387. A Mollier diagram for propylene. (In German.) K. Stephan and G. Scherer. *Chem. Ing. Tech.*, 1961, **33**, 417–20.—A Mollier pressure–enthalpy diagram for propylene is presented, covering the pressure range 0·8–3000 bars and temp −70° to 490° C. The diagram is based on the measurements of Michels *et al*, and the equation of state for propylene by Benzler. An enlarged copy of the diagram is obtainable from the Thermodynamische Institut of the Technischen Hochschule Karlsruhe (W Germany) at cost price. G. D. F.

1388. Methane oxidation initiated by electrical discharge. M. Barber and J. Cuthbert. *Nature, Lond.*, 1961, **190**, 1001.—The apparatus comprised a silica discharge tube through which the discharge products were swept to a glass reaction vessel in which the products could be mixed with another gas. Samples were taken through a pinhole in Pt foil leading to the ion source of a mass spectrometer. Flow rates of 500–700 ml/sec and pressures of 500–750 μ were maintained. The electrical discharge operated at 13,560 kc/sec.

Discharge in methane produced mainly ethane and hydrogen with some ethylene and acetylene, but 40% of the carbon was unaccounted for; oxygen added to the discharge product had little effect. When the oxygen was submitted to discharge and the product mixed with methane, a carbon balance was obtained of 80% ethane, 10% ethylene, and 10% carbon dioxide, and the remaining hydrogen appeared mainly as water. Evidence for the existence of hydroxyl radicals was also found. H. C. E.

1389. Structure of calcium soap fibres. R. J. Bird and G. Rooney. *Nature, Lond.*, 1961, **190**, 337.—A smear of a calcium-based grease made from commercial fatty acids (mainly stearic acid) was placed on the grid of an electron microscope and the oil was washed away. At a magnification of 114,000, two types of soap fibre were seen; some of width 0·06 μ and twisted, other larger and with no twist. In both types striations parallel to the length of the fibres were apparent, with a spacing of 42 Å corresponding with the long-spacing value of 47·5 Å derived from X-ray-diffraction patterns. It is concluded that these striations are due to the "edge-on" view of the layers of metal atoms in the soap structure. H. C. E.

1390. A new approach to blending octanes. W. C. Healy, Jr, C. W. Maassen, and R. T. Peterson. *Proc. Amer. Petrol. Inst.*, 1959, **39** (3), 132–92.—This paper presents new formulæ for calculating the lab ON of multi-component blends. These formulæ, which take into account ON, sensitivity, and hydrocarbon type of the blend components, should be useful both for operating and economic calculations in specific refineries, as well as in industry-wide studies. When fuel components are blended together the ON of the blend may be greater than, equal to, or less than the volumetric average of the ON of its components. The deviation from volumetric average may be several octane units, and with increasing incremental cost of octane improvement, prediction of this deviation becomes economically important. It is believed there are at least two principal reasons for blending deviations: (1) the effect of hydrocarbon type and concn on combustion reactions; (2) the effect of having rated the blending components at different CR implies different engine conditions. Usually, an ON is valid only when used at the engine conditions at which it was determined. These considerations, together with other requirements of a reasonable formula, were the basis for selecting certain functions of common fuel properties for possible use in predicting blending deviations. Formulæ in this programme were developed on 15 blends and checked on an additional 60 blends at three TEL levels; these blends covered a wide range of commercial and experimental gasolines. The number of components per blend varied from two to 15. Alternate forms of the blend formulæ were analysed by least-squares techniques with the aid of electronic computers. Only the formulæ considered to be the most efficient, balancing goodness of fit against complexity, were finally reported. These formulæ contain functions based on ON, sensitivity, and hydrocarbon type. They permit direct calculation of blend research and motor ON at TEL concn of 3·0, 1·5, and 0·0 ml/gal. Blend ON at other TEL concn can be determined by interpolation on a TEL susceptibility chart. The accuracy of the formulæ is reasonably good, as compared to that of the ASTM anti-knock rating technique. (Authors' abstract.)

1391. Effect of ionizing radiations on hydrocarbons. (In French.) A. Chapiro. *Chim. et Industr.*, 1961, **85**, 393–400.—See Abs. **1019**, 1961.

1392. Electrical control of liquids: voltage variation changes orifice discharge. P. G. Morgan. *Elect. Times*, 1961, **140**, 39–40.—Electrical potential applied to orifice alters flow of solids and liq, due to particles becoming charged. For solids angle of spray $\propto$ voltage. Heavy diesel oil too viscous for continuous flow can be discharged freely through small orifice if high voltage applied thereto. H. K.

ANALYSIS AND TESTING

1393. Mass spectrometric hydrocarbon-group analysis of gasolines. (In German.) G. Franke. *Erdöl u. Kohle*, 1960, **13**, 263–6.—I. Analysis of olefin-free products. Gasolines with no unsaturated bonds are investigated by suitable mass spectrometric methods, permitting an expression of the gasoline composition in paraffins, naphthenes, and aromatics. By the same procedure further separation of the aromatics is obtained into benzene, toluene, C_8-, C_9-, etc., aromatics. Estimation of olefin-containing gasolines by mass spectrometry is possible likewise, but takes longer time. Further may be indicated the possibility of combining the results obtained by mass spectrometry with those of uv spectroscopy and gas chromatography. In this way it is possible to decompose widely a gasoline into its individual components. R. T.

1394. Gas analysis with the Uras for the analysis of gases of complex composition. (In German.) W. Schaefer. *Chem. Ing. Tech.*, 1961, **33**, 426–30.—The Uras gas-analyser, developed by the BASF, and its constructional features are described. The instrument operates on a non-dispersive ir spectroscopic principle. The sensitivity towards various common gases and hydrocarbon vapours at atm pressure is reported to be between 0·5 and 0·005 vol %, depending on the gas. The paper also discusses the effects at atm pressure variations and the type of carrier gas, and the elimination of difficulties due to overlapping absorption bands by means of positive and negative filtration. Examples of the use of this instrument are given. G. D. F.

1395. A laboratory-scale high efficiency vacuum fractionation unit. A. A. Mohajer. *J. Inst. Petrol.*, 1961, **47**, 212–18.—A lab high efficiency vacuum fractionation unit is described having the main features of a no-tap multiple fraction cutter, a high-sensitivity pressure control, an automatic control of the boil-up rate, and a manual control of the adiabatic conditions along the column length. The column packing is of the Stedman type, and efficiencies at the two absolute pressures of 50 and 10 mm Hg are 62·7TP max and 35·5TP max respectively. The pressure drop through the column under opti-

mum operating conditions depends on the absolute pressure of fractionation. It rises as the absolute pressure is lowered.

A study of the pressure drop/boil-up rate diagram may act as a guide in choosing the optimum boil-up rate. A. D. S.

1396. Measuring density, specific volume, and cubic expansion coefficient of plastic masses with help of the Haake-Consistometer. (In German.) K. E. Büscher. *Erdöl u. Kohle*, 1960, **13**, 102–6.—An introductory review is presented of processes for expansion coeff and density determination in question or already applied. A new method based on the dilatometric method is described, which permits temp-dependent density measurements with assistance of the Haake-Consistometer (illustrated and described), whose repeat scattering range generally does not exceed $\pm 0{\cdot}001$ g cm^{-3}. With very soft masses (vaseline), or hard masses (high-melting paraffin), a higher error limit may be expected; this, however, can be kept below $\pm 0{\cdot}003$ g cm^3. Examples are given. R. T.

1397. Estimation of very small amounts of propane and propadiene in cracked gases by gas chromatography. (In German.) G. Heuschkel, J. Wolny, and S. Skoczowski. *Erdöl u. Kohle*, 1960, **13**, 98–9.—The process rests on a pre-separation of the main quantity of C_3- and C_4-components in a silicone oil column and freezing out the fraction containing the two substances sought with liq N. The fraction frozen out with liq N is chromatographed on a strongly polar column material. Diethylformamide on sterichamal 20% is especially suitable. Accuracy of the method ($\pm 20\%$) was checked with synthetic mixtures. Detectable limit of each component 5 ppm. R. T.

1398. Simple method for the detection of inhibitors and other important components of insulating oils. (In German.) E. Rey. *Elektrotech. Z.* (*B*), 1961, **13**, 299–303.—Application of thin-layer chromatography (TLC) to examination of insulating oils. 1–8 μg oil placed on silica gel layer (250 μm) on glass plate. Solvent (eluant) added (hexane, heptane, C_6H_6, $CHCl_3$) and oil components distinguished by varying migration speeds. Spraying with suitable reagent (*e.g.* 20% $SbCl_5$, 80% CCl_4) develops colourless cpds to coloured spots, size of which gives quant estimate of concn. Identification by R_F value and comparison with reference material. R_F values and colour reactions tabulated for 17 inhibitors. Procedure distinguishes main hydrocarbon groups. Results by TLC shown for three commercial oils (high-aromatic, low-aromatic, inhibited), also ir and uv spectra (former for group analysis) and usual characteristics (% C_A 16, 2, 8; % C_P 48, 50, 53; n_D^{20} 1·4950, 1·4769, 1·4804; γc8/20° C 25, 35, 32; tan δ 90° C % 0·3, 0·7, 0·04). TLC enables inhibitor depletion in service to be followed, also oil oxidn as shown by results on oils aged by IEC test (100° C, Cu cat, 164 hr, and also extended to 1000 hr); oil regeneration also controllable. (*Cf* Abs. **1412**, 1961.) V. B.

CRUDE OIL

1399. Processing crude oil at low pH. J. A. Biehl and E. A. Schnake. *Proc. Amer. Petrol. Inst.*, 1959, **39** (3), 214–21.—Approx five years ago, the Ohio Oil Co's refinery at Robinson, Illinois, lowered the pH on crude oil overhead receiver waters from an average of 7·5 to 4·3, increased the inhibitor injection into the vapour overhead from 6–10 ppm to 10–15 ppm. This change to lower pH operations resulted in excellent control of corrosion, cleaner equipment, and reduction of ammonia contamination in the hydrocarbon streams. Corrosion rates have been monitored by water analysis, hydrogen probes, electrical-resistance-type probes, and corrosion test coupons. All methods have shown very acceptable corrosion rates. The clean equipment obtained at the low pH operation has greatly reduced maintenance costs, scheduled turn-rounds, and permitted longer runs at increased charge rates. The reduction of ammonia contamination in the hydrocarbon streams has improved the reformer charge stock quality, lowered the costs of chemical treating of dist, and minimized the quantity of corrosive agents in diesel fuels. The paper describes in detail the low pH operation with respect to corrosion and processing during the five-year period. (Authors' abstract.)

GAS

1400. Use of natural gas for laboratories. (In French.) G. Méker. *Chim. anal.*, 1961, **43**, 191–2.—Natural gas distribution systems in France provide 93–97% CH_4 with <40 mg H_2S/m^3, density 0·58, cal val 9·7 thermies/m^3, air/gas ratio for complete combustion 9·5, flame propagation velocity 0·24 m/s, flame temp *ca* 1900° C. Owing to high air/gas ratio mains pressure is 200 mm H_2O. Use in lab equipment is less satisfactory than ordinary town gas, but various burner modifications help to overcome difficulties. For glass blowing O_2 is required, raising both flame propagation velocity and temp. Small size of gas jet methane burner can lead to obstruction difficulties. V. B.

ENGINE FUELS

1401. Pre-flame reactions in diesel engines. Pt V. A study of temperature, pressure, and ignition delay. F. H. Garner, F. Morton, and J. B. Saunby. *J. Inst. Petrol.*, 1961, **47**, 175–94.—The exact nature of the pre-flames and their effect upon ignition temp cannot be determined without a knowledge of the flame temp. With a standard CFR–ASTM diesel testing unit the rapidly fluctuating temp were measured by means of an electro-optical pyrometer. Simultaneous measurements of the variations of pressure were also made using a capacitance type pressure pick-up. The effect of CR, injection timing, and fuel characteristics upon temp and pressure variations throughout the firing stroke were investigated. The temp measurements show the presence of two distinct peaks in the temp–time curve. The first rapid rise in temp occurs immediately after ignition; the temp then falls, rises to a second max, and thereafter gradually falls as the expansion stroke is entered. The intermediate fall in temp is not accompanied by any measurable change in the rate of pressure rise and varies markedly with variations in CR, injection setting, and fuel characteristics. This fall in temp is least apparent at operating conditions giving minimum delay periods.

A thermodynamic analysis of the pressure developed during the pre-flame period has shown that the energy release is constant for a given fuel. At high CR this energy is derived mainly from the compression of the charge, the energy released by the fuel being directly proportional to the delay period. A. D. S.

1402. A decade of progress in motor fuels. W. J. Sweeney and J. F. Kunc. *Proc. Amer. Petrol. Inst.*, 1959, **39** (3), 280–95.—The changes which have occurred in the motor gasoline demand, quality, and technology picture in the U.S.A. during the past decade are reviewed along with the effects which these changes have had on automotive engine design and performance. Gasolines have steadily improved in anti-knock quality and in a variety of other respects during the period in question, but their real cost to the consumer has remained substantially constant. In order to continue to raise anti-knock quality, the petroleum industry has relied to an ever-increasing extent on the use of relatively new refining processes, such as cat reforming and alkylation, as well as on TEL. Other quality improvements have been achieved either by "tailoring" gasolines composition-wise to improve their combustion characteristics or by the use of additives developed to cope with specific performance problems. The automotive industry has taken advantage of the higher quality fuels available on the market by manufacturing engines of higher

CR and, therefore, higher thermal efficiency. Thus far, the trend towards fuels of improved quality for use in engines of improved thermal efficiency has been shown to be sound. This trend may well continue in the future, but its extent will depend on the ability of the petroleum industry to supply fuels showing acceptable performance characteristics at economically justifiable prices. (Authors' abstract.)

LUBRICANTS

1403. Friction and wear. (In German.) R. Schurmann. *Erdöl u. Kohle*, 1960, **13**, 257–63.—Wear is due to lub films too thin to maintain complete lubrication. In boundary lubrication Amonton's law—that friction force is proportional to the vertical load—is valuable for deciding whether—with a definite lubricant—mild or destructive wear takes place. Extremely thin films, which are very hard, can exercise very great adhesive pressures; since they cannot be sheared, displacement is transferred to the solid body. With somewhat thicker films compensating vibrations can be produced if the friction force, with increasing velocity, first falls, passes through a min, then rises again. In these cases the static friction has an appreciable electrostatic moment, and decomp of the solid body surface need not be feared. On the other hand, the inception of scuffing between metallic parts causes compensation vibrations to disappear, because no static charges can be retained on abs pure metal surfaces. Bright stock addn can improve notably the lubricity of a relatively thin oil in a narrow range of mixed friction between boundary and complete lubrication. In the hydrodynamic complete lubrication region shear resistance of a VT-improver determines its usefulness, since the lubricant so prepared becomes highly fluid at high shear gradients. The crit Reynolds number then has a relatively small val, so that the first visc loss is resolved soon in a renewed visc rise. In very high shear gradients large mol can be torn mechanically; this means a const visc loss, which remains if the shear gradient again assumes quite small val. 18 refs. R. T.

1404. Problem of restricted flow of lubricating greases. (In German.) W. H. Kara. *Erdöl u. Kohle*, 1960, **13**, 107–9.—Experiments on various fats show that use of analytical methods for predicting flow behaviour of lub greases under practical conditions is possible only conditionally. Dependence of apparent visc on the velocity- or shear-gradient and flow limit is known from the literature. These analytical presentations are only approximations, owing to the very variable flow behaviour of lub greases. Transferability of flow curves to definite practical causes presumes possibility of converting the current velocity gradient to practical conditions. By experiments with two measuring instruments, errors in this conversion, as a result of assuming Poiseuille flow, may be reduced. Corresponding test results are communicated. R. T.

1405. Mechanism of oxidation of transformer oils. V. Prabhashankar and D. J. Badkas. *J. Inst. Petrol.*, 1961, **47**, 201–11.—In a study of the mechanism of oxidn in the BS 148 and IEC tests the effect of the different parameters on the vapour and liq reactions were investigated. The combination of the two-phase reactions was then analysed and the effect of cat discussed. It was concluded that both of these oxidn tests have inherent limitations which are partly due to the test procedures and partly to the complicated effects of oil composition and cat on the oxidn process. Some of the test limitations may be removed by changing the specifications for the apparatus and the procedure of testing. It is suggested that the tests may be made more useful if oxygen absorption is measured, and the acid, sludge, and peroxide formation shown as a function of it.

The mathematical formulæ for the determination of oxygen absorbed by the oil and the effect of temp on the air-space reaction rate are developed in the appendixes. A. D. S.

SPECIAL HYDROCARBON PRODUCTS

1406. Paraffin, its composition and phase behaviour of its most important components, the normal alkanes. (In German.) W. M. Mazee. *Erdöl u. Kohle*, 1960, **13**, 88–93.—The rheological behaviour of *n*-alkanes—the major constituent of dist waxes—is influenced widely by existence of a conversion pt in the range between 21° and 36° C. Binary mixtures of *n*-alkanes may form an unbroken series of mixed crystals or, with widely separated numbers of C-atoms, dissociate completely to give a normal eutectic. Conversion temp for mixtures can be considerably lower than for the pure components. The α-modification is very plastic, the β-modification rather hard. This is important, since the rheological behaviour of the wax is determined chiefly from the presence of this plastic phase. Ten refs. R. T.

1407. Effects of hydrostatic pressure, temperature, and voltage duration on the electric strengths of hydrocarbon liquids. K. C. Kao and J. B. Higham. *J. Electrochem. Soc.*, 1961, **108**, 522–8.—Electric strengths of simple hydrocarbons and transformer oil, determined by multiple pulse technique, found to increase with applied hydrostatic pressure (up to *ca* 300 psi) and decrease with increasing pulse duration (mainly in range 1–10 μ sec) and temp (−60° to 120° C). Tests mainly with hemispherical (¼-inch dia) stainless steel electrodes, and multiple electrodes in same cell, gaps mainly 200 μ. Suggested that electric breakdown is partly governed by dielectric layers on cathode, which change with successive breakdowns, latter taking place in gas or vapour bubble. H. K.

1408. Chemistry of cable oil deterioration. G. Feick, W. F. Olds, and E. D. Eich. *J. Electrochem. Soc.*, 1961, **108**, 56–60.—See Abs **1708**, 1960.

1409. A new polymer for wax. L. W. Blight and D. C. Sutherland. *Mod. Packag.*, July 1961, 134–40, 198.—The Elvax vinyl resins, copolymers of ethylene and vinyl acetate, are versatile, high mol wt resins which are compatible with paraffin wax. Coatings made from Elvax/wax blends, containing 30–40% resin, are colourless, transparent, non-tacky, glossy, and completely flexible. They are suitable for a wide variety of packing uses, of which the main function is providing a water-vapour barrier. The specific adhesive properties of Elvax allow substrates coated with unmodified blends of Elvax and ordinary paraffin wax to be heat sealed to materials which are normally resistant to heat sealing, *e.g.* aluminium foil, K type cellophane, Mylar polyester film, and polyethylene film.

Several methods for applying polymeric coatings containing Elvax to a wide variety of substrates have been examined and are briefly described. A. D. S.

1410. Insulating oils for transformers. (In French.) T. Salomon *et al.* *Bull. Ass. franç. Tech. Pétrole*, 1961, 259–72.—Symposium. Historical survey, followed by appreciation of present situation and indication of future trends, latter include increased transmission voltage (400 kV) leading to raised oil temp (up to 100° C or more); limiting factor in temp rise is cellulose insulation rather than oil. Discussion shows trend to thinner oils (20 cS/20° C), leading to drop of 10° C in oil temp for unchanged winding temp or, if oil temp maintained, a 3% rise in permissible load. French practice is tending to N_2 sealing rather than use of inhibitors; gas evolution under stress is considered of minor importance. V. B.

1411. Effect of dissolved gases on the electrical conduction and breakdown of insulating oil. H. Tropper. *J. Electrochem. Soc.*, 1961, **108**, 144–50.—Glass apparatus, sealed from atm;

tests with dc; spherical ½-inch dia electrodes, gap 25–150 μ; oil to BS 148 (28 cS/21° C, % C_A 8·5, % C_P 53·7). Electrode metal affects results, stainless steel giving val 40% higher than Cu, Cr, Al, steel. Breakdown preceded by conduction current, during flow of such current (up to 20 microamp) light emitted from stressed oil region. Breakdown strength critically dependent on air (O_2) content of oil, increasing then decreasing therewith. Max val *ca* 1200 kV/cm. V. B.

1412. Assessment of inhibited and non-inhibited insulating oils for transformers. (In German.) E. Rey and L. Erhart. *Bull. SEV*, 1961, **52**, 401–13.—Transformer oil deterioration in service discussed. Review of analytical methods. Data, including ir (yielding % C_A, % C_P) and uv spectra given on nine oils, four of which inhibited (d_{20} 0·851/892; visc cS/20° C 20/39; n_D^{20} 1·4729/4950; % C_A 4/17; % C_P 46/78; furfural number 0/6·4). After IEC oxidn (25 g, 1 litre O_2/hr, 164 hr, 100° C, Cu cat) sludge 0/0·37, acidity 0·02/0·84, tan δ 90° C % 1·0/80. Owing to complexity and relative insensitivity of ir spectra, thin layer chromatography (*cf* Abs **1398**, 1961) is a much preferable analytical technique, enabling oxidn products, inhibitors, impurities, to be detected at 10^{-6}; hydrocarbon groups distinguishable, selectivity better than ir. Inhibitor depletion, oil oxidn, regeneration can thereby be followed. Measurement of tan δ, although of value as indicating oil condition, bears no relation to aging test results, *e.g.* aged inhibited oil having zero sludge and acidity 0·11 had highest tan δ of whole series, probably due to very low naphthene content (% C_N = 11). Gas absorption (*cf* Abs **1323**, 1960) of six of the oils was measured under air, N_2, H_2. Gas absorption being generally incompatible with oxidn stability is considered a characteristic of secondary importance, since transformers should be operated at much below ionization stress. Inhibited oils show sufficient advantage over straight to warrant general use. 50 refs. V. B.

DERIVED CHEMICAL PRODUCTS

1413. Chemical intermediates from hydrocarbon sources. J. R. Blanco. *Chem. & Ind.*, 1961, 802–10.—Processes for production of petroleum chem are surveyed and products and their uses as chem intermediates indicated. These include production of aromatics by cat reforming and extractive dist and by Catarole process, hydrodealkylation of higher aromatics to C_6H_6 and $C_{10}H_8$, oxidn of C_3H_6 to acrolein, production and uses of ethylene and propylene oxides, synthesis of bio-degradable detergents, and uses of Al alkyls. W. A. M.

1414. Production of butadiene. J. A. R. Bennett. *Chem. & Ind.*, 1961, 410–15.—Lecture and discussion. Esso process for cat dehydrogenation of C_4H_8 to C_4H_6 is described in detail, including preparation of feedstock, purification of product, and disposal of by-products. Ten refs. W. A. M.

1415. Benzene by new catalytic dealkylation process. Anon. *Industr. Chem.*, 1961, **37**, 279–80.—Brief description with simplified flow diagram of Detol process for conversion of toluene and xylenes to C_6H_6 by cat dealkylation in presence of H_2-containing gas. W. A. M.

1416. Further notes on petrochemical raw materials for synthetic textiles. P. W. Sherwood. *Industr. Chem.*, 1961, **37**, 229–30.—Use of toluene for production of caprolactam, C_2H_4 and NH_3 for production of acrylonitrile, and alternatives to high-cost *p*-xylene, are briefly reviewed. *Cf* Abs **895**, 1961. W. A. M.

1417. Growth of propylene demand due to new products and technological progress. (In French.) P. W. Sherwood. *Chim. et Industr.*, 1961, **85**, 401–8, 576–87.—General review of propylene as petrochemical raw material. Discussion of fundamental reactions (hydration, alkylation, oxidn, chlorination, chlorhydration, OXO-reaction, polymerization, ammonolysis) whereby main intermediate and final products derived from propylene are obtained. Descriptions of methods for manufacture of: acetone, glycerol, propylene oxide, nonene, dodecene, polypropylene, etc., derived from C_3H_6; economics of the various processes considered. (Author's summary.)

1418. Production of lithium alkyls and their exchange with organic halogen compounds. (In German.) E. Terres *et al.* *Erdöl u. Kohle*, 1960, **13**, 84–8, 160–3.—Pt I. Production of lithium organic cpds. Pt. II. Production of definite hydrocarbons over lithium organic cpds.—Polyaddition of ethylene lithium ethyl—Pt I. Different Li-alkyls in mixtures and pure are prepared and decomp with various halogen containing products. Reaction with alkyl- or allyl-chlorides leads to well-defined products, whereas decomp with cpds containing a halogenation at a double bond is complex and yields—along with gaseous products—very high-mol end products. Pt II. Li-ethyl is shown to react with C_2H_4 by a basically different mechanism than its higher straight chain homologues. According to the C_2H_4 quantity, centres of mass are formed in the addition, which obey a growth law and, by use of Taylor's series, can be expressed mathematically. The Li-alkyls so produced were decomp with acetylchloride to methylalkylketones and methyldialkylcarbinols, and the reaction products separated by rectification into individual components. The hydrocarbons formed in a secondary reaction could not be separated from the ketones by dist, since paraffins interfere with ketone identification. Composition of individual fractions was determined by a developed physical comparison method. All the saturated and unsaturated cpds were rectified over packed columns. Physical data determined were compared with published val. 24 refs. R. T.

COAL, SHALE, AND PEAT

1419. Chemism of coking, investigated on polymeric coal model materials. VI. Plastic behaviour during coking. (In German.) P. M. J. Wolfs, H. I. Waterman, and D. W. van Krevelen. *BrennstChemie*, 1959, **40**, 342–6.—Valuable results are obtained in investigating the plastic behaviour of model materials by Arnue–Audiberts' dilatometer method, pen experiments, and visual judgment. Changes in bridge-number during coking indicate two possibilities. One is that b^*, polymerization intensity (bridge number structural unit), reverts intermediately during primary coking through depolymerization. Subsequent increase follows the reversion because monomer units set free as tar vaporize, also the remaining monomer units are built into a new aromatic skeleton with new cpd formation. Linear polymers and polycondensates with not too complicated net structure ($1 < b^* < 1{\cdot}3$) are fusible through intermediate reduction of b^* (with or without decomp). Non-functional model materials and polycondensation products of phenetole and 2-methylnaphthalene with formaldehyde belong to this material type. A second possibility is that transformation of the aromatic skeleton sets in immediately at the coking commencement, because, first, the functional groups are split off. Phenols and *p*-bromophenol-novolakes belong to this material type. These materials are fusible only if the polymerization intensity of the original material is <1. At coking commencement solidification sets in. This material type behaves directly opposed to the first-named material. Each possibility is presented in a diagram in which polymerization intensity b^* is entered against temp. Plastic behaviour during heating can be explained simply from relative positions of decomp and softening curves. All spectra found for coal of dilatation curves and profiles of coking residues can be obtained also with model materials by well-considered changes in monomer unit type and polymerization intensity b^*. Seven refs. R. T.

CORROSION

1420. Predict furnace tube corrosion rate. G. R. Port. *Oil Gas J.*, 15.5.61, **59** (20), 155–9.—At Shell Oil Co's Wood River refinery, the problem of hydrogen sulphide corrosion has been investigated, and over the past five years they have measured corrosion rates on 5% chromium–steel furnace tubes. These data have been averaged and correlated with some of the operating variables in a crude oil dist unit. The results show that corrosion rate increases when: (1) charge rate is increased —this is a result of the higher tube-wall temp; (2) metal temp moves above 640° F—above this point, test specimens show that corrosion rate increases considerably when using alloy steels of less than 7% chromium content; (3) velocity through the tubes exceeds 200 ft/sec.

For dist units processing sour crude, steel alloys with higher than 5% chromium content are cheaper than lower chromium steels, since they can remain in service longer under severe conditions, such as the radiant section of a furnace. A. D. S.

1421. Corrosion by sulphur and its compounds. (In Spanish.) V. G. Aranda. *Combustibles (Zaragoza)*, 1960, **20**, 67–78.—Lecture, under heads of: elemental S, SO_2, SO_3, and H_2SO_4, H_2S, inhibitors. Extensive bibliography. V. B.

SAFETY PRECAUTIONS

1422. Economics of a sound safety programme. 5. Build accident prevention into your safety programme. J. H. Herbert. *Oil Gas J.*, 6.3.61, **59** (10), 122–4.—In the last of this five-part series it is emphasized that the following well-developed plans should be formalized. Securing written approvals before action takes place, making a formal safety study during the course of the design, selection and placing of new equipment, and giving formal safety consideration when new products or processes are developed or when new materials are to be used, all help in reducing accidents. There is great economic value in a formal disaster-control programme. All staff should be familiar with what they should do in such circumstances. Finally, all supervisors and key personnel should receive regular training in fire extinguishing and first aid. Mutual-aid plans amongst oil company plants in an area are helpful, and to be effective this requires regular discussions between plant representatives. A. D. S.

1423. Foam compounds for use against fires in water miscible solvents. P. Nash and R. J. French. *J. Inst. Petrol.*, 1961, **47**, 219–22.—A study of " all-purpose " foam cpds which are effective against fires in both hydrocarbons and water miscible solvents is reported. The tests indicate that such foams can give a reasonable performance provided that they are applied gently to the surface of the burning liq. When projected into the liq their performance is likely to suffer badly and the fire will not be controlled. For application to petrol fires, a greater quantity of " all-purpose " cpds than normal protein cpd is likely to be required for fire control. The factor of increase is likely to vary between one and a half and ten times as much, dependent on the cpd used and the rate of application of foam/unit fire area. For solvent fires an " all-purpose " cpd is necessary, with consumption varying from one to five times that of a normal protein cpd on a petrol fire. A. D. S.

ECONOMICS AND MARKETING

1424. International oil and gas take to pipelines. E. Adams. *Petrol. Engr*, June 1961, **33** (6), A25.—After a brief outline of world pipeline activity, the paper presents brief details of oil and gas production, consumption, exploration, refinery capacity and throughput, and other relevant information for 62 countries from Aden to Italy (to be completed in a later issue). G. D. F.

1425. Japan's growing petrochemical industry. Anon. *Petroleum, Lond.*, 1961, **24**, 225.—The development of the petrochemical industry in Japan since 1955 is outlined by means of tables, etc. The first-term programme and its economic effects are mentioned, and the objectives for the second-term programme are discussed briefly. G. D. F.

MISCELLANEOUS

1426. Are we losing by inches? J. J. Arps. *Petrol. Engr*, June 1961, **33** (6), B44.—The author points out the many advantages of using the metric system in petroleum engineering Examples show that in metric units many routine calculations can be performed in less than a quarter of the time required at present. G. D. F.

1427. Optimize cyclic processes. H. E. Schweyer and F. P. May. *Petrol. Engr*, June 1961, **33** (6), C33.—It is shown that the optimization of cyclic operations may be broadly classified as one of two types—those dealing with max average production rate and those dealing with minimum costs. Equations for these two types of optimization processes are developed, and are illustrated by means of an example. G. D. F.

1428. Dust in gas streams. 1. The physics of small particles. J. R. Ehrenfeld *et al.* *Petrol. Engr*, June 1961, **33** (6), D30.—The forces on a particle suspended in a fluid medium consist of one or more of the following: (1) inertia; (2) drag; (3) gravity; (4) buoyant; (5) diffusional (Brownian motion); (6) thermal; and (7) electrical. The origins of these forces are discussed. Particle dynamics and the electrical, optical, and thermodynamic phenomena associated with particles are outlined. G. D. F.

1429. Functional relationships in natural hydrocarbon prospecting and producing organizations. (In French.) R. Schlumberger. *Bull. Ass. franç. Tech. Pétrole*, 1961, 129–45.—Lecture, covering personnel (staff) organization.

1430. Oil industry is achieving recovery of earning power. L. J. Logan. *World Oil*, June 1961, **152** (7), 138.—Net earnings of major oil companies in the U.S.A. during the first quarter, 1960 and 1961, are analysed. Record of earnings during the first quarter of 1961 was exceptionally good, and the level is expected to be high in the second quarter. The first half of 1961 is proving to be the most profitable six months during the past four years. During the first quarter of 1961, 41 U.S. oil companies reported an aggregate profit of $892,519,000, 14·2% higher than in the first quarter of 1960. This is due mainly to higher prices for oil products, but also to the intensive cost-cutting and efficiency campaign. C. A. F.

1431. Research Council of Alberta. Anon. *Nature, Lond.*, 1961, **190**, 872.—46th annual report covering the year 1960.

The presence of capsules in a flowing stream (*e.g.* in a pipeline) does not significantly alter pressure gradients or distort the flow. The capsule velocity depends directly on its length and inversely as its dia. The transport of mixtures of pulverized coal and oil has been studied.

The conversion of *cyclo*propane to propylene over crystalline aluminosilicates as cat has been studied. H. C. E.

1432. Petroleum in Japan's energy picture. Anon. *Engineer, Lond.*, 1961, **212**, 30–1.—Review covering 1960 production (5×10^5 tons), consumption ($17{\cdot}6 \times 10^6$), imports (foreign exchange allocation, etc.), refining capacity (37×10^6), and petrochemicals. Forecasts for 1970. Also included are petroleum marketing and exploration, tanker construction (£47/ton). H. K.

1433. Australian oil search report. Anon. *Petroleum, Lond.*, 1961, **24**, 229.—Brief details of the activities of organizations engaged in oil exploration in Australia and in Papua–New Guinea from Nov 1960 to March 1961 are reported. G. D. F.

1434. U.K. petroleum refining industry. Anon. *Fluid Handl.*, 1961, 71–4.—PIB memorandum gives location, capacity, and brief description of refineries in the U.K. W. A. M.

1435. Austrian oil production. Anon. *Engineer, Lond.*, 1961, **212**, 169–71.—1958 production: oil $2{\cdot}7 \times 10^6$ tons, gas 468×10^6 m³; refining capacity $1{\cdot}8 \times 10^6$ tons. Description of new Schwechat refinery, including atm dist unit (5000 ton/day), gas after-treatment (720 ton/day), Unifier-Platformer (7000 bd), and bitumen plant (400 ton/day); this will increase annual refining capacity by $1{\cdot}6 \times 10^6$ tons. H. K.

BOOK REVIEWS

Asphalts and Allied Substances. Vol. I. Historical Review and Natural Raw Materials. 6th Edn. Herbert Abraham. Princeton, London: D. Van Nostrand, 1961. Pp. xiii + 370. 81*s*.

Workers throughout the world interested in the chemistry and technology of bitumen and asphalt are familiar with the name of Herbert Abraham as the distinguished author of the leading reference text-book on the subject. The author has been the head of the American Ruberoid Co for many years and the first edition of " Asphalts & Allied Substances " was published as early as 1918, when the industry was scarcely out of its infancy. Although this book was not widely known outside the U.S.A., a second edition was required in 1920, and this speedily became world-famous. Further editions appeared in 1929, 1938, and 1945, the last of these being a monumental work in two volumes, dealing in considerable detail with virtually every aspect of the subject, although, understandably, not so fully with those techniques more familiar on the Eastern than on the Western side of the Atlantic. Since 1945 there have been considerable developments in the field of bitumen and asphalt, and it was therefore of great interest to learn that yet another edition of Abraham's famous work was to be published. It is indeed a remarkable undertaking for an author to produce six editions of such a work, and Mr Abraham is to be congratulated most heartily. The new edition is to be in six volumes, of which only the first has so far appeared.

This Vol I consists of a historical review and, after chapters on the terminology, chemistry, geology, and production of asphalts, describes the various natural asphalt deposits throughout the world. A list of 195 books is appended, followed by 270 references to the literature and separate indexes of subjects, authors, and patents.

Although in many ways very comprehensive and most valuable, the new Vol I is rather disappointing, as it seems still rather out-of-date in certain respects. It is, for example, surprising to-day to find petroleum classified as " a species of bitumen " and to read that the only differences between " bitumen " and " asphalt " are that " asphalt " must be dark in colour and that " bitumen " can be of relatively high volatility. One reads (p. 57) that in " Europe, the term ' asphalte ' is applied to unconsolidated limestone impregnated with asphalt, which softens and crumbles when subjected to a moderate heat, whereas the term ' bituminous rock ' is used to designate consolidated limestone rock impregnated with asphalt, which resists high temperatures without crumbling." This would seem to indicate a lack of understanding of British nomenclature, as used in the industry on this side of the Atlantic and given official blessing here in a variety of British Standards as well as in the " Glossary of Petroleum Terms," published by the IP. Correspondingly, there is no reference to the extensive work carried out on this very complex terminology by the Permanent International Association of Road Congresses and summarized in the well-known " Technical Dictionary of Road Terms in Six Languages," published by that body. The British Standards Institution is even described (p. 62) as the British Engineering Standards Association, a title which was changed in 1931.

In the chapter dealing with the geology and origin of bitumen the various modes of occurrence are described under the three headings of overflows, impregnated rocks, and filled veins, the various theories of the origin of the materials being described in some detail in three sections dealing respectively with inorganic, vegetable, and animal theories. A section on the metamorphosis of petroleum into asphalts, etc., is followed by a section dealing with the origin and metamorphosis of what the author describes as non-asphaltic pyrobitumens. The indicated theories regarding the origin of the natural asphalt lakes are open to a certain doubt. In this latter connexion, it is also disappointing to find the later description of the methods of winning and refining lake asphalt somewhat remote from normal present-day practice. This position would have been helped at numerous points in the book if it had been possible to include better quality and more up-to-date illustrations.

The following chapter on production is interesting, although one regrets that world production data is not available after 1931. Up to that time, the greatest tonnages are seen to come from the U.S.A. with—rather surprisingly—Italy second, Trinidad third, and Germany fourth. At least in the U.S.A. the greatest proportion of the asphalt is utilized for paving purposes.

The chapters dealing with the individual natural raw materials are particularly comprehensive, and it is doubtful if there are many asphalt deposits anywhere in the world to which reference is not made. It would have been useful if more information could have been given of the relative commercial importance of the various deposits at the present time, as in some instances the material has been virtually worked out, whilst other deposits have never been of more than purely local significance. The difficulty of this is, however, evident, although some checking with the major natural asphalt firms might have helped.

The reviewer hopes that the comments which he has made will not be overstressed by the reader, as there is no doubt that the new Vol I will prove to be a most valuable reference book and—with the following volumes still to be published—will be an essential addition to the library of all organiza-

tions and individuals concerned with this rather involved, but most interesting and important subject. D. C. B.

Proceedings of the International Symposium on Distillation, Brighton, England, 1960. Ed. P. A. Roltenburg. London: Institution of Chemical Engineers, 1961. Pp. 278. 80*s* (60*s* to members of sponsoring bodies).

"Trifles make perfection," wrote Michelangelo, and it is good to remember that one of the greatest workmen of all time did not disdain tiny advances in his daily labour. The design of distillation equipment is still an art, however much the calculation of the number of stages required and the plant conditions may be reduced to science and rule; and one who practises the art on a large scale, knowing that only optimum performance and minimum costs will justify his choices, has to restrain his impatience in reading the papers of this Symposium much more so than when, by reading technical papers as they come, he meets papers on distillation one at a time.

There are three aspects to the problem of distillation. First, vapour–liquid equilibrium studies, which show how many distillation stages are needed. Secondly, a device must be constructed to perform a distillation stage, the object of which is complete mixing of liquid and vapour, followed by their complete separation. Thirdly, this device must perform the distillation stage within the minimum vertical travel of liquid and vapour; the criterion is how many stages are accomplished per foot height of column within the practical range of column loading. If this very summary statement of the matter be accepted, it appears that separation of equilibrium vapour from the tray liquid is the real difficulty. In practice most trays are spaced 24 inches; of this about 3 inches of vertical height is used to mix the vapour and the liquid and the remaining 21 inches used to separate them. A 100-foot high column uses 12 feet to mix liquid and vapour and 88 feet to separate them. If by intensive study the speed of mixing can be doubled, which no one supposes, the column becomes 94 feet high. If the separation can be done twice as fast, the column becomes 56 feet high: this seems, however, to be an unstudied aspect of distillation.

The reviewer, having admitted his prejudice, will now review the book. The papers are well arranged in six sessions of five papers, each followed by a discussion. Sessions one and two were devoted to mass transfer, with a welcome contribution on steam distillation and a study of the ammonia–water system, notoriously non-ideal in its behaviour. Session three concerned vapour–liquid equilibria, very useful papers showing application of recent analytical methods and high pressures. Session four was on packed columns: here the methods of research are of interest; it is so hard to apply results obtained on one packed column to another. Sessions five and six were devoted to tray columns, with several papers giving performance data from commercial installations, and some giving comparison of modern design for trays.

Anyone who wishes to keep in touch with modern work on distillation will read this volume with profit. The papers are all of a high standard. The reviewer feels his mind was well fed even if what he really wanted was not on the menu.

D. P. P.

Destillier- und Rektifiziertechnik. 3rd Edn. E. Kirschbaum. Berlin, Göttingen, Heidelberg: Springer-Verlag, 1960. Pp. xvi + 415.

The author of this book has for many years enjoyed a distinguished reputation for his work in the field of distillation. The book itself is widely known through the two earlier editions, the first of which appeared in 1940 and the second in 1950. In preparing the new edition the author has aimed at extending the treatment of physical and theoretical fundamentals, while at the same time linking them with their application to practice. Some of the main changes in the new edition may be briefly indicated.

Partial condensation of mixtures is treated in more detail. The sections dealing with plate efficiency and the factors affecting it have been expanded, and the results of more recent experiments have been included. The section on packed columns has undergone considerable revision. The method for calculating the height of packed columns on the basis of heat transfer, which was originally developed by the author, has been omitted. The appendixes, which give equilibrium data for various mixtures, have been curtailed on the grounds that compilations of such data are now available in other publications.

The book is an excellent one, and the new edition will maintain the high reputation of its predecessors. Nevertheless, this reviewer feels that there are points which may be criticized, while realizing that some omissions may be inevitable because the subject of distillation has now become so vast that adequate coverage in a single book presents an extremely difficult problem. The treatment of ideal mixtures of more than three components remains unchanged in the new edition. Only five pages are devoted to mathematical methods for calculating fractionating columns for such mixtures; the relevant bibliography is scanty and the numerical example given relates to a ternary mixture. The experimental work referred to in connexion with the performance of plate columns and packed columns is predominantly from the German literature. (It naturally includes the valuable work carried out by the author over a period of many years.) The Ponchon–Savarit method for binary mixtures is described in detail, but there is no mention of the names of these important contributors to the subject of distillation.

A. J. V. U.

ADDITIONS TO THE LIBRARY

Entries are in subject order arranged according to the Uren "Classification for Petroleum Bibliography," the number preceding each entry indicating the classification and corresponding to that used in the "Library Catalogue" published by the Institute.

094 American Petroleum Institute. API bulletin on thread compounds. 4th ed. New York, API, 1960. 9 p. (API Bulletin 5A2.)

094 American Petroleum Institute. Official list. Publications of the Division of Production, American Petroleum Institute. 38th ed. New York, API, 1961. 12 p. (API Bulletin 82.)

094 American Petroleum Institute. API recommended practice for conversion of English to metric units as applicable to API standards on tubular goods. New York, API, 1960. 4 p. (API RP. 5D.)

094 American Petroleum Institute. API recommended practice for hoisting tool inspection and maintenance procedures. New York, API, 1961. 18 p. (API RP. 8B.)

094 AMERICAN PETROLEUM INSTITUTE. API recommended practice for testing oil-well cements and cement additives. 10th ed. New York, API, 1961. 37 p. (API RP. 10B.)

094 AMERICAN PETROLEUM INSTITUTE. API recommended practice for placement of electrical equipment on productive leases. New York, API, 1961. 15 p. (API RP. 11J.)

094 AMERICAN PETROLEUM INSTITUTE. Recommended practice and standard form for electrical logs. 2nd ed. New York, API, 1959. 8 p. (API RP. 32.)

094 AMERICAN PETROLEUM INSTITUTE. Recommended practice for standard calibration and form for nuclear logs. 2nd ed. 12 p. New York, API, 1959. (API RP. 33.)

094 AMERICAN PETROLEUM INSTITUTE. Recommended practice standard procedure for the evaluation of hydraulic fluids. New York, API, 1960. 16 p. (API RP. 39.)

094 AMERICAN PETROLEUM INSTITUTE. API recommended practice for core-analysis procedure. New York, API, 1960. 55 p. (API RP. 40.)

094 AMERICAN PETROLEUM INSTITUTE. Fire protection in refineries. 4th ed. New York, API, 1959. 26 p. (API RP. 2001.)

094 AMERICAN PETROLEUM INSTITUTE. API specification for oil-field V-belting. 3rd ed. New York, API, 1961. 29 p. (API Std. 1B.)

094 AMERICAN PETROLEUM INSTITUTE. API specification for casing, tubing, and drill pipe. 24th ed. New York, API, 1961. (API Std. 5A.)

094 AMERICAN PETROLEUM INSTITUTE. API specification for drilling and production hoisting equipment. 4th ed. New York, API, 1961. 12 p. (API Std. 8A.)

094 AMERICAN PETROLEUM INSTITUTE. API specification for wire rope. 16th ed. New York, API, 1961. 25 p. (API Std. 9A.)

094 AMERICAN PETROLEUM INSTITUTE. API specification for subsurface pumps and fittings. New York, API, 1961. 44 p. (API Std. 11AX.)

094 AMERICAN PETROLEUM INSTITUTE. API specification for pumping units. 9th ed. New York, API, 1961. 24 p. (API Std. 11E.)

094 AMERICAN PETROLEUM INSTITUTE. API specification for small welded production tanks. 5th ed. New York, API, 1961. 15 p. (API Std. 12F.)

094 AMERICAN PETROLEUM INSTITUTE. API specification for oil and gas separators (Tentative). 2nd ed. New York, API, 1961. (API Std. 12J.)

094 AMERICAN PETROLEUM INSTITUTE. Centrifugal pumps for general refinery services. 3rd ed. New York, API, 1960. 26 p. (API Std. 610.)

094 AMERICAN PETROLEUM INSTITUTE. Measurement of petroleum liquid hydrocarbons by positive displacement meter. New York, API, 1960. 99 p. (API Std. 1101.)

094 BRITISH STANDARDS INSTITUTION. Specification for screw gauge limits and tolerances. Part 1. Gauges for screw threads of unified form. London, BSI, 1960. 40 p. (BS 919: Part 1: 1960.)

094 BRITISH STANDARDS INSTITUTION. Centre-line-average height method for the assessment of surface texture. London, BSI, 1961. 38 p. (BS 1134 : 1961).

094 BRITISH STANDARDS INSTITUTION. Specification for butt-welded, single point cutting tools and blanks. London, BSI, 1961. 22 p. (BS 1296 : 1961.)

094 BRITISH STANDARDS INSTITUTION. Extract from B.S. 1500: Pt. 1: 1958. Fusion welded pressure vessels. Part 1. Carbon and low alloy steels. Sections 4 and 5 and Appendix A. Manufacture, workmanship, inspection and testing. London, BSI, 1960. 46 p. (BS 1500A : 1960.)

094 BRITISH STANDARDS INSTITUTION. Specification for length bars and their accessories. London, BSI, 1961. 33 p. (BS 1790 : 1961.)

094 BRITISH STANDARDS INSTITUTION. Recommendations for letter symbols, signs, and abbreviations. Part 2. Chemical engineering, nuclear science, and applied chemistry. London, BSI, 1961. 45 p. (BS 1991: Part 2: 1961.)

094 BRITISH STANDARDS INSTITUTION. Recommendations for letter symbols, signs, and abbreviations. Part 3. Fluid mechanics. London, BSI, 1961. 35 p. (BS 1991: Part 3: 1961.)

094 BRITISH STANDARDS INSTITUTION. Recommendations for letter symbols, signs, and abbreviations. Part 4. Structures, materials, and soil mechanics. London BSI, 1961. 49 p. (BS 1991: Part 4: 1961.)

094 BRITISH STANDARDS INSTITUTION. Recommendation. for letter symbols, signs, and abbreviations. Part 5. Applied thermodynamics. London, BSI, 1961. 30 p. (BS 1991: Part 5: 1961.)

094 BRITISH STANDARDS INSTITUTION. Specification for gear hobs. Part 2. Hobs for gears for turbine reduction and similar drives. London, BSI, 1960. 12 p. (BS 2062: Part 2 : 1960.)

094 BRITISH STANDARDS INSTITUTION. Specification for carbon steel pipe flanges (over 24 inches nominal size), for the petroleum industry. London, BSI, 1960. 19 p. (BS 3293 : 1960.)

094 BRITISH STANDARDS INSTITUTION. Specifications for unit heads (slide type). London, BSI, 1960. 15 p. (BS 3295 : 1960.)

094 BRITISH STANDARDS INSTITUTION. Methods for locating the centre of gravity of heavy objects. London, BSI, 1961. 20 p. (BS 3318 : 1961.)

094 BRITISH STANDARDS INSTITUTION. Specifications for gear planing and shaping machines. London, BSI, 1961. 16 p. (BS 3329 : 1961.)

094 BRITISH STANDARDS INSTITUTION. Specification for piping systems for the petroleum industry. London, BSI, 1961. 55 p. (BS 3351 : 1961.)

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OILFIELD EXPLORATION AND EXPLOITATION

GEOLOGY

1436. Optical activity of petroleum: applications in geochemistry. (In French.) M. Louis. *Rev. Inst. franç. Pétrole*, 1961, **16**, 263–74.—Optical activity was first observed in petroleum over a century ago, and various suggestions have been made about the substances causing this: these include breakdown products of proteins, naphthenic acids, and cholesterol. Some studies suggest a diminution in activity in the older crudes, but detailed studies have shown a wide range in the Carboniferous oils. However, in a given field for several horizons of the same general age the values were similar. The activity of fractions is a max at mol wt of *ca* 400. The active components resisted the action of H_2SO_4.

In tests the fractions distilling below 250° C have low activity. After removing these and precipitating asphaltic material, the remaining material was broken down into ten fractions by dist at 0·01 mm pressure. When oils from the

Paris Basin were studied, two wells producing from the Bathonian gave similar curves and comparable mean values. There was no regular trend with age, but a broad reduction in the mean value with increased age. Splitting one oil into paraffinic and naphthenic fractions gave higher values in the former. This may be due to preferential solubility.

It is suggested that the measurements may be used to estimate losses in oil evolution. G. D. H.

1437. How lithologic zoning of dolomite helps find oil. J. P. Hobson. *World Oil*, July 1961, **153** (1), 63.—The classification of dolomites and their genetic relationships are discussed. Broadly they are of two types: (1) very fine grained and impermeable, and (2) relatively porous and permeable. The former commonly serves as a cap rock and the latter forms valuable reservoirs whose properties are strongly enhanced by acidization. Studies of dolomites in the Beekmantown of SE Pennsylvania and the Ellenburger of Central Texas show that both types exist in each, and it is shown that dolomites formed by dolomitization of limestones often have good reservoir properties and in many cases occur beneath fine grained dolomites. The basal parts of thick dolomite units are thus potential drilling targets, and regionally the best prospects are where shelf dolomites interfinger with basinal marine limestone. Isopachyte and lithofacies maps will aid the location of these areas. Examples of dolomite traps are described, and it is emphasized that more attention to detail in lithological descriptions of dolomites is required. 13 refs. C. A. F.

1438. Make the most of those electrical logs if you want to find strat traps. D. A. Busch. *Oil Gas J.*, 10.7.61, **59** (28), 162.—Precise correlations of subsurface formations cannot be obtained without electrical logs, and these are now proving indispensable in defining stratigraphic trap prospects. The logs provide markers for identifying and analysing genetic sequences enabling the surface of deposition of reservoir sand to be reconstructed. Examples of electric log cross-sections are given, and an example of an analysis of a stratigraphic trap in Oklahoma is given. Two refs. C. A. F.

1439. Reef fever spreads into East Texas. C. Stevens. *World Oil*, July 1961, **153** (1), 68.—Oil development in reef limestone is spreading to E Texas in an area hitherto considered an unlikely reef province. The target is the James limestone, which occurs in the Cretaceous Lower Rodessa, Glenrose–Trinity group in the Tyler Basin. 22 producers have now been completed in the Fairway–Frankston field, with potentials up to 570 bd from pays of 20–100 ft. The pay is a facies of the James consisting of a fossiliferous, oölitic, coquinoidal limestone. The geology of the Fairway–Frankston field is described: it consists of a NW–SE reef resting on and striking perpendicular to a deep-seated anticlinal ridge bounded on both sides by salt domes. There is minor faulting, and max buildup is *ca* 200 ft, of which 100 ft is porous and permeable. There is solution gas drive with oil–water contact from 9550 to 9575 ft subsea. Original bottom hole pressure was *ca* 5200 psi, and average porosity and permeability are 13% and 50 mD. Connate water ranges from 25 to 50% of pore space. Oil is *ca* 48°, and reserves are estimated at up to 100 million brl in place, of which 18% should be recoverable by primary methods. C. A. F.

1440. Texas' on-again-off-again country now on again. F. J. Gardner. *Oil Gas J.*, 19.6.61, **59** (25), 161.—11 fields have been found in Concho County in Central Texas, but only four remained productive until recent months, when a new field was discovered at North Speck. Two pays were found by 1 R. L. Carter, the upper in Strawn Pennsylvanian sand producing 185 bd of 46·2° oil from *ca* 3580 ft and the lower in Canyon Pennsylvanian yielding *ca* 70 bd from *ca* 3200 ft. A more recent strike is also reported. A map shows the location of the Concho County fields. C. A. F.

1441. Gulf Coast has a new champion at Vienna. F. J. Gardner. *Oil Gas J.*, 12.6.61, **59** (24), 179.—There is active development of the deep Wilcox trend in S Texas, where the 30th reservoir has been found. The discovery, 1 Kolar, in the Vienna field, Lavaca County, was completed in the Wilcox at *ca* 16,400 ft. Production was gas at 4700 Mcf/day with a shut-in tubing pressure of 10,600 psi. This is the deepest Wilcox gas pay yet found, and it should stimulate deep drilling throughout the middle Gulf Coast. The Wilcox is an unusual formation and has erratic development in the Gulf Coast as a whole, with very variable porosity and permeability and thick shale sections. C. A. F.

1442. San Juan drillers tap Pennsy pay with new discovery. J. C. McCaslin. *Oil Gas J.*, 10.7.61, **59** (28), 170.—Almost all the production from the San Juan Basin of NW New Mexico has come from Cretaceous rocks, but recently gas and condensate have been found in the Pennsylvanian Paradox Barker Creek zone at *ca* 7110 ft. The test, 3–18 Table Mesa, flowed 21,500 Mcfd plus 1515 brl condensate/million. Gas contains 5·4% helium. Most of the new fields discovered in the basin yield from Cretaceous rocks, the most recent success being the Cha Cha trend in San Juan County. C. A. F.

1443. Upgrade Lower Minnelusa plays with lithofacies maps. W. N. Zakis. *World Oil*, 1.8.61, **153** (2), 67.—Regional facies maps of rock types in the Lower Minnelusa formation of Wyoming, Nebraska, and S Dakota have given new data on prospective oil and gas areas in the region, where structural data alone are inadequate. The Minnelusa forms a prospective sequence in the NW Denver Basin and the contiguous part of the Powder River Basin, and major structural elements such as the Black Hills and Chadron Arch had an important influence on sedimentation. These are discussed and isopachyte and lithofacies maps of the Lower Minnelusa are presented. There are indications that the formation was deposited in a marine environment. Five refs. C. A. F.

1444. Pan Am high on its mountain wildcat. F. J. Gardner. *Oil Gas J.*, 17.7.61, **59** (29), 125.—A well is to be drilled on Red Table Mountain, a large surface structure in Eagle County, W Colorado. The site will be at 11,200 ft, the highest yet to be drilled, and the target is the Devonian Chaffee Zone at *ca* 7000 ft. Nearest production is from Cretaceous Mesaverde at Baldy Creek, 26 miles to the W. Location is based only on surface geology, and seismic work was unsuccessful because of the terrain. The structure is elongated and tectonically part of the White River Uplift of NW Colorado. Air and mud will be used in the drilling. C. A. F.

1445. Niobrara discoveries enhancing NW Colorado prospects. B. Coltman and W. D. Pitt. *World Oil*, July 1961, **153** (1), 80.—There are excellent prospects in NW Colorado, where new discoveries are being made in many pays, particularly in the Cretaceous Niobrara. Recent exploration has indicated several new on-structure areas of fractured Niobrara shale production, and one of the oldest producing structures, the Tow Creek anticline, has now yielded new oil from the pay. The regional structure of the area and the geology and reservoir characteristics of the Niobrara are described. Production comes from fractured zones, mainly in the limy sections within the basal 300 ft. Fracturing is especially developed at the sharp axes of anticlines. Other promising oil and gas pays in the area include Pennsylvanian Weber sandstone, Trias Shinarump conglomerate, the Jurassic Entrada sand, and lenticular Tertiary sands. C. A. F.

1446. Canadians hunt for miniature reefs. F. J. Gardner. *Oil Gas J.*, 10.7.61, **59** (28), 161.—There is active exploration in SW Ontario in the area of the oldest Canadian oil production. The main target is the Silurian Guelph–Lockport pinnacle reefs. These have been known since 1889, and 15 had been

drilled by 1951, of which nine contained oil or gas. From 1951 to 1955 24 new reefs were found, of which ten produced gas and two oil. Since 1955 gravity surveys have indicated many further pinnacles which have not yet been drilled. The reefs are small, averaging less than ¼ section in basal area. Along the shores of Lakes Hurin and St Clair it is hoped to find oil or gas in the reefs at depths of only 1500–1800 ft. Some reefs have been found tight, the pores being plugged with salt or anhydrite. C. A. F.

1447. Characteristics of brines in the northern wing of the Amelia field, Turaszowka well. (In Polish.) T. Szefer and K. Wittek. *Nafta (Krakow)*, 1958, **14**, 233–6.—The article presents results of full brine analyses of the Turaszowka wells; all samples originate from the bottom of the drill-holes, but sometimes they include seepages from other strata. Though the total salts vary from 0·6 to 0·2% the ratio of Cl to Na, Cl to CO_3 ions, and other similar identifying aspects, allowed to compare these waters. Full details are tabulated and summarized in conclusions. M. S.

1448. An attempt at new stratigraphic division of menilite series and Krosno beds. (In Polish.) S. Jucha and J. Kotlarczyk. *Nafta (Krakow)*, 1958, **14**, 205–7.—Polish technical literature considers menilite series to belong to Upper Eocene, while the Rumanian sources classify it as Oligocene; similar opinion has been recently expressed by the Soviet geologists. Since the menilite is generally associated with crude, the question is always important. The matter hinges upon the presence of Upper Eocene fossils in the secondary bed. The authors explain this by postulating the formation of the menilite beds in various times in various places. M. S.

1449. Determination of trace elements in rocks by spectrography. (In Polish.) Z. Biernat and M. Solecki. *Nafta (Krakow)*, 1958, **14**, 214–16.—In the Polish IP work on spectrographic analysis started in 1953 in the Krosno area, but without satisfactory results. American papers recommend use of dc arc and high dispersion apparatus, which Polish IP has not got. Neither are there any pure materials for comparison. For these reasons a relative quantitative method has been used. Apparatus has been modified. Six indicative elements have been used: V, Ni, Cr, Sr, Mg, Ba. To establish strata in Sub-Carpathians two boreholes were used; to test the method some work has been done in the Lowlands. Though one well produced samples with 17 elements, a comparison of four, namely, V, Ni, Cr, and Cu, gave satisfactory indication. Two strata have been identified, though in order to obtain confirmatory data some quantitative analyses have been done on various salt solutions. Wells are identified by code letters and figures. M. S.

GEOPHYSICS AND GEOCHEMICAL PROSPECTING

1450. The status of geochemical prospecting. G. D. Hobson. *Petroleum, Lond.*, 1961, **24**, 255.—It is shown that surface geological mapping may be insufficient in some cases, and more recent techniques have to be used. One such method is geochemical prospecting, which is outlined in some detail. Bacteria identification is also dealt with. An evaluation of recent Soviet work is carried out. G. D. F.

1451. Airborne geophysical surveying. L. Q. Gaither and W. G. Egerton. *Oil Gas J.*, 12.6.61, **59** (24), 180.—Airborne electrical field intensity surveying can be conveniently carried out with a conventional twin-engined aircraft. Continuous recordings are made of one or more electrical fields produced from separate sources, and the recorded data are analysed and contoured on area maps. Aerial photos shot at the same time as the survey are used for horizontal control, and results of the geophysical survey are presented in units of microvolts per metre. It is shown that contours of higher intensity correlate very well with high geological structures. Details of the equipment are given, together with examples of surveys over several areas in Texas. C. A. r.

1452. Geophysical research and the American Petroleum Institute. T. J. O'Donnell. *Proc. Amer. Petrol. Inst.*, 1959, **39** (3), 466–86.—The cost of finding a brl of new oil is rising at an alarming rate. The reserve situation in the U.S.A. will become serious in a few years unless discovery efficiency can be improved by developing better methods and reducing costs. The three principal geophysical exploration methods—gravity, magnetics, and the seismograph—have benefited from technological advancements in recent years, but techniques used now are not far from the frontiers of present scientific knowledge. The API recognized the need for increased fundamental research in geophysics and recently began supporting research in universities, principally in fundamental studies of elastic wave propagation. This field of study is pertinent to seismic exploration, the most definitive and most costly of present geophysical methods.

(Author's abstract.)

1453. Revised method interprets electric logs in oil-wet rocks. S. J. Pirson and C. D. Fraser. *Petrol. Engr*, July 1961, **33** (7), B32.—It is shown that oil-wet zones in a well can be recognized on electric logs, and that the quantitative method of interpretation for water-wet zones is not applicable to these regions. A new interpretation procedure for oil-wet zones is developed, and examples of its application are provided. The new method appears to give results which compare well with actual well productivities. G. D. F.

1454. Gravity-magnetics can be an effective tool for oil finders. R. A. Geiger. *Oil Gas J.*, 17.7.61, **59** (29), 126.—Although gravity and magnetic exploration have been used for many years, they are often misused and results are not properly interpreted. The methods are most effective when used together and the cost is relatively small, compared to seismic. The uses of both surveys are outlined and for gravity work in local geological problems the approx size of the target should be determined in advance. From a knowledge of the geology of an area it can be determined whether a structure for a given depth has sufficient density or susceptibility contrast with the surrounding formations, or expected relief, to yield a recognizable anomaly. C. A. F.

1455. Geophysics and the petroleum industry. (In Polish.) A. Kislow. *Nafta (Krakow)*, 1958, **14**, 207–10.—There has been great progress in crude discoveries since the second world war. Two methods are available: surface search and rock analysis. They are the two parts of geophysical science. Though expensive, this kind of work allows savings to be made in the process of search for oil. The expenditure in the West is of the order of $350–400 million, well over half of this being spent in the U.S.A. In the U.S.S.R. there were in operation 237 seismic groups in 1956 and 360 in 1957; there were 45 gravimetric groups in 1956. 24 seismic and four gravimetric groups worked in Poland in 1957. In the U.S.A. the peak of 710 seismic groups occurred in 1952 and their number of has now fallen to 560 approx. Since the average of 200,000 tons reserve is discovered per group, the geophysical work in the U.S.A. shows a profit of $2000 million. Similar profits on smaller scale can be seen in other countries. In Poland the fruits of limited work are small, partly due to lack of knowledge of the country's geology and partly due to the existence of a thick quaternary deposit. This kind of work must be instituted irrespective of the capital investment involved. New equipment must be obtained, but attention must also be paid to keeping it in good repair and making good use of it. M. S.

DRILLING

1456. Can WOC time be reduced? W. G. Bearden and R. D. Lane. *World Oil*, 1.8.61, **153** (2), 77.—" Waiting on cement " times can be reduced to 4–8 hr by proper selection of cement. Results of lab and field tests which have confirmed this are described, the study being carried out to: (1) re-establish the minimum strength requirements of cements in oil wells; (2) determine times of attainment of minimum strength of cements; and (3) formulate a revised WOC policy. The tests and their results are described in detail with charts, and the field applications of reduced WOC times are discussed.

C. A. F.

1457. How new foaming agents are aiding air/gas drilling. J. L. Lummus and B. V. Randall. *World Oil*, July 1961, **153** (1), 57.—Use of foam in air/gas drilling has allowed faster and cheaper drilling in many areas. It is also useful for removing extraneous water in workover and well deepening operations. Tests of several hundred foaming agents in the field have shown that there is no direct correlation between physical properties of surface active agents and their ability to remove water and cuttings from a well whilst drilling with air or gas. A quantity, the Foam Index (FI), is described from model well test results, and this has proved a satisfactory means of rating foaming agents for field use. Other results of the tests include the development of a new foaming agent which is effective in the presence of contaminants such as NaCl. In one well $57,000 were saved in drilling costs by using a combination of foam and dry air drilling compared to a similar well drilled with mud. Seven refs. C. A. F.

1458. Well bore pressure surges produced by pipe movement. J. A. Burkhardt. *J. Petrol. Tech.*, 1961, **13**, 595–605.—Raising or lowering pipe in fluid-filled holes causes swabbing (negative) or fracturing (positive) surges. These could lead to blowouts or lost circulation. The pressures and pipe velocities have been measured experimentally, and surge generation has been examined theoretically. A positive peak occurred when the pipe was moving at max velocity; negative peaks occurred in lifting off the slips and in braking pipe movement. The theory predicts the sequence and magnitude of the surges, the most important of which are usually due to viscous drag of flowing mud. There may also be pressure generated by breaking the mud gel, and due to the inertia of the mud column. The negative surge when lifting off the slips could be caused by the last two factors. Equations have been developed for the viscous drag surge for closed pipe and open pipe, and these, although approx, allow predictions within the degree of experimental accuracy. G. D. H.

1459. How a French contractor keeps his rigs working. T. E. McDowell. *Drilling*, May 1961, **22** (7), 40.—A French drilling contracting firm employs 25 rigs in France, Spain, Algeria, Madagascar, and the Ivory Coast. Most are fitted with electrodynamic brakes, automatic driller, air slips and tongs, a flush rotary table, and desanders, and use 5-inch drill pipe. A centrifugal pump is used for mud-mixing and supercharging mud pumps. Rigs are lit by sodium floodlights on towers away from them, reducing fire risk. Most equipment is made in France under licence for American firms. As France has no reservoir of drilling labour, rig personnel are carefully selected and trained on the assumption that they will stay with the firm for a long time. Warehouses at Montpellier, Bordeaux, and Algiers, and sub-warehouses in each major drilling area assure prompt supply of spare parts.

J. C. M. T.

1460. First Canadian electric rig working in Swan Hills. Anon. *Drilling*, May 1961, **22** (7), 52–3.—The first diesel electric dc rig in Canada has been designed for exploration in the N, and can be broken into units suitable for transport by cargo aircraft. The rig has been converted from steam power. One, two, or three generators can be connected to either of two pumps and/or the draw-works. J. C. M. T.

1461. Experimental stress analysis of tool joints. J. F. Gormley. *J. Petrol. Tech.*, 1961, **13**, 496–500.—The test machine was a modified lathe acting as a fatigue machine for full-size tool joint or drill-collar specimens. A hydraulic load cyl resting on the lathe bed applied bending moments. Paper-backed strain gauges were used. Zinc-base grease was applied to the joint, which was screwed hand tight, whereon zero readings were taken on all strain gauges. The joint was then screwed to some higher torque value, and new strain readings were taken. The joint was then rotated, so that the gauges gave the max and minimum strains resulting from bending moment. Bending loads were increased until perceptible shoulder separation occurred. Repeat runs were made at higher make-up torques.

Stresses in the tool joint due to bending were found to be linear up to a point where the stress on the tension side of the pin rose in an increasing non-linear manner. The transition was at a point where friction between pin and box due to make-up torque was insufficient to transmit the bending load; the transition was higher the greater the make-up torque. The suggested field-practice torque range is correct, with the high side safer than the lower end of the torque range. Distribution of make-up stress in a tool joint pin is very irregular.

G. D. H.

1462. Theory of formation cutting using the sand erosion process. R. W. Brown and J. L. Loper. *J. Petrol. Tech.*, 1961, **13**, 483–8.—Various theoretical relationships have been developed between penetration rate, threshold cutting power, pressure differential across the nozzle, and distance penetrated. At least two reliable test points are needed to fix certain constants, and then the data can be applied to other materials, provided the hardnesses are known. Computed max penetrations in open hole range from 14·6 inches for granite to 46·6 inches for a sandstone, with 2000 psi nozzle pressure drop. Penetration *v.* time plots show considerable flattening with increase in time.

For cased conditions perforation size affects performance, and the larger the perforation, the greater the penetration rate and depth of penetration. Fluid cavity tests under cased conditions showed cavity pressure to rise with nozzle pressure differential, and to be reduced with increase in perforation area.

Hydraulic power in the jet decays as the square of the ratio of distance along the jet axis to nozzle dia. Stand-off is needed to avoid jet damage by back-splash. The optimum sand concn seems to be 0·75–2 lb/gal. If fluid re-enters the borehole other than via the perforation the penetration performance is improved. G. D. H.

1463. Investigation of abrasive-laden fluid method for perforation and fracture initiation. F. C. Pittman, D. W. Harriman, and J. C. St. John. *J. Petrol. Tech.*, 1961, **13**, 489–95.—It can be shown that the theoretical power for the abrasive-laden fluid varies as the 3/2 power of the pressure drop across the nozzle for a given dia of jet, density of fluid, and proportion of sand. In tests the rate of penetration of a steel plate at a given pressure drop diminished with increase in stand-off distance, becoming zero at 6 inches for 1000 psi drop. Splash-back damaged the jet face and mounting. Greater stand-off and a suitable housing gave the mount a life the same as the life of the jet, but reduced cutting rate. So long as the jet stream cannot cavitate, depth of submergence had little effect on cutting rate. After 20–25 minutes there is little further penetration; the penetration is greater in soft formations. In 20–25 minutes at a stand-off of ¾–1¼ inches the hole produced is *ca* three times the jet dia. Longer pumping widens but

does not deepen the hole. The width of a circumferential cut in steel pipe is *ca* 2½ times the jet dia, irrespective of pumping time. A circular cut goes deeper than a straight perforation.

Any type of fluid, gelled or un-gelled, can be used. 10–20 sub-angular sand cuts 25% faster than 20–40 Ottawa sand. Oil will have a greater velocity through a jet for a given pressure drop, and should cut faster. Perforations through pipe into cement and formation give a potato-shaped hole behind the pipe of dia *ca* ½ cut depth.

There can be pipe motion due to pump pulsations, temp, and stretch under pressure. A mechanical hold-down has been devised. Accurate placing is necessary for correct cutting.

G. D. H.

1464. Simplified analysis aids in optimizing drilling factors for minimum cost. H. W. R. Wardlaw. *J. Petrol. Tech.*, 1961, **13**, 475–82.—Penetration rate is not the sole criterion of drilling efficiency. Cost per ft drilled is more important. The actual drilling cost factor (h) is defined as the number of rotating hours per 100 ft. Instantaneous drilling rates can be obtained by Lubinski's drill-off method, employing the elastic properties of steel and the observed rate of change of drilling wt with the brake chained down. This was practicable up to rates of 120 ft/hr in sandy shales. The actual drilling cost factor decreased rapidly and linearly with increased weight on bit, then less rapidly but linearly, and at the highest wt showed a slight rise with increase in wt. The breaks varied with the formation and with the hydraulic conditions. The actual drilling cost factor decreases with increase in rotary speed, the curve flattening, and increases linearly with rise in the reciprocal of the rotary speed. The factor decreases slightly with increased hydraulic hp. Penetration rate and drilling cost factor varied approx logarithmically with depth.

$H = h[1 + (t_t + b)/t_b]$, where H is the overall cost of drilling in hours/100 ft, t_t the round-trip in hr, b the equivalent cost of the bit in hr of rig time, f the bit footage in hundreds of ft, and $t_b = hf$.

Bit life decreased with increase in mud sand content.

An example showed the lowest cost for convenient operation to be 5·1 hr/100 ft drilled, at 72,500 lb and 150 rev/min, which in terms of money ($120/hr) would be $6·12/ft. G. D. H.

1465. Vertical well drilling techniques. (In Serbo-Croat.) I. Karanjac. *Nafta* (*Yugoslavia*), 1960, **11**, 257–83.—The author describes the conception and methods of techniques applied to drilling vertical wells to greater depths. These are: (1) the use of stabilizers; (2) the use of large dia drill pipe; (3) deliberate acceptance of larger deviation; (4) drilling of wells of larger dia than normal and use of oversized drill pipe. The problem of controlling the vertical position is dealt with particularly, as well as the method of estimating danger and deviation. The author gives some practical results obtained on oilfields by application of the methods mentioned.

(Author's abstract.)

1466. High mud weight presents unusual problems. H. G. van Laar and R. R. Lewis. *World Oil*, July 1961, **153** (1), 45.—Drilling in the Agha Jari field of SW Persia is complicated by severe lost circulation, extreme high pressure water flows, and presence of salt beds. These require a specialized mud programme which is described in detail. The upper hole in Upper and Middle Fars marls and sandstones requires only conventional fresh-water mud of caustic-tannate treated bentonite. The second casing string is set at *ca* 6000 ft into the top of the Lower Fars, and it is this formation, of marls, anhydrites, and salt beds of variable thickness, which causes difficulties. For this lower section of the hole, salt saturated muds with densities of 130–165 lb/cu ft are used to combat abnormal water pressures. Satisfactory flow is maintained with a mud cyclone used intermittently. The mud is used only until the cap has been penetrated to 20–30 ft. A "non-solids" mud is used as a completion fluid in the Asmari pay limestone.

A typical well in the field used *ca* 1500 tons of mud materials, (mainly salt and barite), costing *ca* $75,000 in Iran.

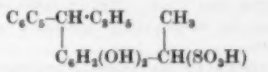
C. A. F.

1467. Hydraulic transmission for oil well servicing. Anon. *Engineer, Lond.*, 1961, **212**, 407 (see also *Fluid Handl.*, 1961, 252–4).—Description of hydraulic drive developed by BP; schematic layout, illustr. H. K.

1468. Equipment for twisting and untwisting pipes in geological-exploratory drilling. Anon. *Nafta* (*Krakow*), 1958, **14**, 224–5.—This type of equipment is of Soviet origin. It is driven by an electric motor and deals with drilling pipe of 50–60 mm dia. It is here described on the basis of information originating from "Gipronyeftyemash." M. S.

1469. Integrated equipment type MSP-2 for mechanized lowering and raising operations when drilling. Anon. *Nafta* (*Krakow*), 1958, **14**, 225.—This type of equipment is of Soviet origin; it is here described on the basis of material originating from "Gipronyeftyemash." This mechanism is driven by compressed air at 4·5–8 atm available at the rate 3 cu. m./min. It is claimed that through mechanization possible with this type of equipment a saving of 10–12% of the time was possible. Many such units are in use. M. S.

1470. Highly valuable tannin of the lignin type and its effects on rheological properties of mud. (In Polish.) F. Esterka. *Nafta* (*Krakow*), 1958, **14**, 211–14.—The tannin developed in Czechoslovakia bears the name of chloroalkaline lignosulphite. It is obtained from post-sulphitic lye from paper and cellulose. It is a brown powder, of pungent odour, insoluble in cold water, soluble in hot with acid reaction in soln, in alkalis, and in sodium sulphite soln. Its composition (with values after chlorination in brackets) is: OCH_3—10·52% (1·89%); OH—7·59%(3·80%); SO_3H—9·83%(4·93%); O—8·16%(21·40%); and Cl—0·0%(21·45%). The product has oxidizing properties; the formula is given as



before chlorination; chlorine enters propylobenzene (two atoms), and two –OH groups are converted to =O. The chlorinated cpd has better stabilizing properties and is unaffected by salts up to 1% concn. In the field, tests have shown that this cpd is resistant to heating and air. It is claimed to be very efficient with bentonitic suspensions; it may replace quebracho. M. S.

1471. Packer mud: results obtained at Lacq. (In French.) M. Labouysse, A. Garcia, and A. Nicolau. *Bull. Ass. franç. Tech. Pétrole*, Jan 1961, (**145**), 41–55.—Packer mud is placed in the annulus between the tubing and casing and above the packer to prevent gas escape should the packer fail. The density must be *ca* 1·9, and the weighting material must not settle out; it should not cement the tubing. In 1954 a bentonite–CMC–barytes mud was adopted. 12 wells have been completed with a light mud, and 13 with heavy mud. The packer mud has 5 g/l of CMC and basically 5% of bentonite, with additions to give gel strength of 130 lb/100 ft². The drilling mud is replaced after lowering the production packer and tubing, using reverse circulation. Contamination must be avoided.

Tables give data on the muds and other matters for the operations at Lacq involving packer mud. There is also some information on the use of these muds in the U.S.A.

The quality of the bentonite and CMC and the size distribution of the barytes are important. Gel strength and vise must be at the highest values practicable. G. D. H.

PRODUCTION

1472. Chlorine logging in cased holes. J. T. Dewan, O. L. Stone, and R. L. Morris. *J. Petrol. Tech.*, June 1961, **13**, 531–7.—Chlorine logging is best applied where there is high water salinity, high porosity, and high oil saturation in producing horizons; it is not applicable in brackish formations or where the porosity or oil saturation is low. Depth of investigation may be 6 inches for high porosity, and 1–2 ft at low porosities. Filtrate invasion will affect the log in uncased holes; in cased holes the invaded zone disappears soon after setting casing.

The new tool is relatively insensitive to porosity; it responds to chlorine concn rather than to the total amount of chlorine. It is made sensitive to chlorine neutron capture γ rays. It was tested in simulated cased holes in loose sands, with the casing empty, filled with fresh water, and filled with salt water. For salinities of 50,000–100,000 ppm the effect of porosity is small. Salinity resolution is best in empty casing, poorest when the casing is full of salt water. There is neutron capture by casing, cement, and formation. Formation porosities are obtained by running a neutron log simultaneously.

An interpretation technique is described which is reliable only in relatively clean formations, and a number of log examples are given. The chlorine log often markedly resembles an SP log. Gas is generally indistinguishable from oil. In the Gulf Coast area zones condemned by the chlorine log have almost invariably on testing proved non-productive.

G. D. H.

1473. Natural gas hydrates at pressures to 10,000 psia. H. O. McLeod and J. M. Campbell. *J. Petrol. Tech.*, 1961, **13**, 590–4.—Binary mixtures of methane, ethane, propane, *n*-butane, and *iso*butane were injected into a high pressure cell containing an excess of dist water. Hydrates formed and were melted to find their decomposition temp at pressures of 1000–10,000 psia.

Up to 4000 psia the results generally confirmed previous work, except for methane–*n*-butane, and apart from this an increase in specific gravity was accompanied by an increase in hydrate decomposition temp. Above 6000 psia plots of log pressure *v.* temp are substantially straight, parallel lines for different systems.

The hydrate crystal lattice seems to be pressure sensitive at high pressures. It seems that all gas hydrates crystallize in one cubic structure or in a combination of two cubic structures, the gas molecules being " trapped " in cavities in a framework of water molecules. One type has two sizes of cavity, methane, ethane, and H_2S being able to enter the small cavities, and the higher hydrocarbons can enter only the large cavities.

A modified form of the Clapeyron equation can be used to predict hydrate formation between 6000 and 10,000 psia. An example of the calculation is given. G. D. H.

1474. Propping fractures with aluminium particles. L. R. Kern, T. K. Perkins, and R. E. Wyant. *J. Petrol. Tech.*, 1961, **13**, 583–9.—The permeability of a fracture depends on its width and on the permeability of the propping material. Sparse propping particles will increase permeability, provided that there is not undue crushing on embedding: malleable aluminium particles will deform slightly under load without shattering. The spreading increases the bearing area, and reduces penetration. There is some work hardening.

The behaviour of aluminium particles under load has been studied, as were the penetration of steel dies into rock and the permeability of sparsely propped cracks. Theory and experiment showed the logarithm of the fracture conductivity to decline roughly linearly as the formation stress increased.

In field tests 8–12-mesh aluminium has been used to follow 20–40-mesh sand. The resulting productivity was several times greater than would have been expected without the aluminium, which in one case was only 500 lb, compared with 17,500 lb of sand. G. D. H.

1475. Effect of reservoir environment on water–oil displacements. J. R. Kyte, V. Q. Naumann, and C. C. Mattax. *J. Petrol. Tech.*, 1961, **13**, 579–82.—Cores were taken using brines or bentonite–carboxymethylcellulose mud, which had been shown not to affect the wettability of samples, and preserved in brine. Conventional imbibition and water flood tests were made, and comparable tests were made under reservoir conditions. For water flood the high pressure test was executed first, using aquifer cores and bottom-hole crude, followed by de-pressuring, and a water flood under surface conditions, with refined oil.

Two reservoir rocks with intermediate wettability under surface conditions showed as strongly water-wet at reservoir conditions. The third core showed a small increase in water wettability under reservoir conditions, and this may originally have been water-wet, but surfacing caused an irreversible change. In water flooding more oil was displaced under subsurface than under surface conditions after the injection of one pore vol of water; there was also much more oil recovery at water breakthrough. The rock samples were from high-temp and high-pressure reservoirs. There may be increased preferential adsorption of crude oil components at low temperatures. G. D. H.

1476. Some effects of size distribution on particle bridging in lost circulation and filtration tests. C. Gatlin and C. E. Nemir. *J. Petrol. Tech.*, 1961, **13**, 575–8.—Furnas' theoretical relationship for max density of packed solids gives the ratio of the quantities of successive sizes of interval $\sqrt{2}$ as $r = 1/\phi^{n/m}$, where ϕ is the porosity of a bed of one size, m is one less than the number of screens used, and n is one less than the number of component sizes taken from a plot of ϕ against the logarithm of the ratio of the dia of the smallest and largest particles.

Filtration tests against a wedge-shaped slot using a nut shell sample and one prepared to match Furnas' relationship in a mud showed the latter to give a bridge but not the former.

In filtration tests using standard API equipment and filter paper on 2-inch thick sandstone cores, the presence of a max density distribution of " large " particles reduced the spurt loss for filter paper. In the cores the damage depth was in general less for the max density mixture, but the data were scattered. The deletion of " large " particles from colloidal drilling muds gives high spurt muds, but once bridging occurs the behaviour appears normal. A high spurt loss mud by reducing the pressure gradient across the bottom of a well reduces chip hold-down forces and so facilitates cutting removal in drilling.

G. D. H.

1477. Ten years of miscible displacement in Block 31 field. E. H. Harbeck and J. R. Blanton. *J. Petrol. Tech.*, 1961, **13**, 543–9.—The Devonian Block 31 was the first miscible drive and involves injection of high pressure lean gas (3500 psig for miscible displacement). There are 15 wells on a nine-spot pattern taking 57 MMcf/day; the production is 15,350 bd. The Devonian is 7900 ft deep and 1000 ft thick. The main oil is in a 350-ft interval 450 ft below the top. It has dense and permeable streaks, and may have as much as 185 ft of pay. Average porosity is 15%, average permeability 1 mD, connate water 37%. The initial pressure was 4145 psig and the saturation pressure 2764 psig. There are 75 wells in 11 sq miles. Injection began in 1949, 3½ years after discovery, when cumulative production was $3{\cdot}7 \times 10^6$ brl, and pressure 3650 psig. Experience had shown that one injection well could support three producers. The crestal wells are capable of taking 10 MMcf/day or more; in the N the capacities are 2–4 MMcf/day.

A volumetric balance is computed each month to indicate

where corrections are needed for a balance. There are annual pressure surveys, using a 96-hr build-up with extrapolation. There was trouble from injection wells becoming plugged, the material being mainly iron sulphide, compressor lubricant, and some free sulphur, the main cause being the use of too much lubricant in the compressors, with water vapour a secondary cause due to reaction with H_2S. Improved drying removed the latter cause. Washing of clogged wells with 5000 gal each of gasoline, xylene, and acid was most effective. Injection profiles were measured. Some channelling of gas behind casing was noted with two injection wells. Squeezing closed the channels. Six wells have suffered gas breakthrough. Above a gas/oil ratio of 30,000 : 1 there is little oil recovery. In some cases breakthrough has been attributed to a fault or to there being less reservoir oil than calculated.

55×10^6 brl of oil has been produced. Primary recovery would have been *ca* 25% of the oil in place; miscible drive is expected to raise the figure to 50%. Overall performance has been about as predicted. G. D. H.

1478. Influence of production rate, permeability variation, and well spacing on solution gas-drive performance. G. J. Heuen, G. C. Clark, and J. N. Dew. *J. Petrol. Tech.*, 1961, **13**, 469–74.—The mathematical model assumed radial, unsteady-state, two-phase flow with dissolved gas drive, and not more than 50 concentric cells were used, varying logarithmically in size, the smallest being at the well bore. Saturations, pressures, and flow rates were calculated for each cell as a function of time. The reservoir simulated was a tight dolomitic limestone with wide and rapid changes in porosity and permeability, both horizontally and vertically. Various parameters were varied, including spacing and the radial position of a tight zone.

80-acre spacing gave substantially the same overall recovery as 40-acre spacing, but required *ca* twice the time. Restricting output to 100 bd instead of 200 bd initially does not significantly change recovery to the economic limit, but increases the time. A substantial permeability restriction sited some distance from the well only slightly reduces recovery at the economic limit. Zones of decreased permeability some distance from the well can produce short-term increases in producing rate and decreases in gas/oil ratio. Two low-permeability zones separated by normal permeability gave two rises in producing rate. Permeability variations tend to hold down gas/oil ratios; drilling into a tight zone gives a flat decline curve after a steep initial drop, and parts of it resemble the behaviour attributed to gravity drainage. G. D. H.

1479. Data show how salt content changes compressibility of reservoir brines. G. Long and G. Chierici. *Petrol. Engr*, July 1961, **33** (7), B25.—The importance of knowing the compressibility of reservoir brines is outlined. Determinations of the formation vol factor (FVF), density, and compressibility have been carried out for brines made of NaCl in dist water at temp 68°–212° F, pressures 28·5–7117·7 psig, and salinities 0–300 g/l. The results are presented in the form of numerous graphs, the use of which is illustrated by means of an example. There is also a discussion of the effect of dissolved gas on FVF and compressibility. G. D. F.

1480. Measuring of the so-called " permeability profile " and of communications between injecting and producing wells by means of radioactive tracers. (In Serbo-Croat.) J. Loncaric, M. Ferencic, and V. Peros. *Nafta* (*Yugoslavia*), 1960, **11**, 178–81.—The article describes methods for the investigation of communications between oil wells on the occasion of water or gas injection performed for oil exploitation by secondary methods. It demonstrates further measurements of input and output permeability profiles of water. Advantages of using radioactive isotopes in general and especially in the Petisorci field near Lendava are considered.

(Authors' abstract.)

1481. How to determine equity percentages in unit operations. D. R. Allen and B. V. Savoy. *World Oil*, July 1961, **153** (1), 52.—With increasing numbers of unit operations it is becoming more important to establish quickly and accurately net oil sand. Several methods for establishing clean and wet lines are described, and techniques for isopaching across oil–water contacts and fault planes are noted.

Selecting the appropriate technique is important where the equity of individual operators may be disordered by improper selection of a workable contour interval or feather edging techniques along oil–water contacts or fault planes.

C. A. F.

1482. Small diameter well completions. Pt 1. Economics and application. R. W. Scott and J. F. Earl. *World Oil*, 1.8.61, **153** (2), 57.—Small dia well completions are being increasingly used in the oil industry and a full range of equipment is now available. Workovers can be carried out successfully in casing down to 2⅞ inches dia. Small dia pipes can be used for single completions and for concentric dual and parallel multiple completions. Combination parallel and concentric multiples have been completed extensively in S Texas. Completions have been successful to depths below 12,000 ft and their main advantages are: (1) major savings in completion costs; (2) small reservoirs can be depleted economically; and (3) old wells and doubtful pays can be re-evaluated at minimum cost. Disadvantages include: (1) restriction of production; (2) unsuitability for fracture treatment; and (3) difficulties from crooked casing. Factors to be considered in recommending slim hole operations include sizes of hole, drill pipe or tubing, hydraulic requirements, rig and component equipment, bits, and fishing equipment. Each of these is discussed and tables show costs and slim hole hydraulic data. C. A. F.

1483. Evaluating the heat wave process. S. E. Szasz. *World Oil*, 1.8.61, **153** (2), 89.—*In situ* combustion, or the heat wave process, was developed as a tertiary recovery method to follow primary and secondary depletion. The injection requirement and cost of the process is proportional to the bulk vol of the swept area of the reservoir and not to the oil content or pore vol. Profitability depends mainly on compression costs and oil content per unit bulk formation vol, since the ratio between injected gas and swept formation vol is high. The heat wave process is described qualitatively and quantitatively, together with variations which have attempted to improve performance.

C. A. F.

1484. How downhole rubber liners can help you. G. L. Gore. *World Oil*, 1.8.61, **153** (2), 73.—Tests of a temporary downhole and rubber liner have proved successful in preventing fluid loss from well bore to formation. It consists of a four-ply, nylon cord–reinforced neoprene hose, slightly larger in dia than the hole or casing in which it is to be used. Ends are tapered to a smaller dia to receive a short, drillable, brass sleeve. The liner is operated on the principle that tension on the hose reduces its dia and compression increases its dia. Tests have shown that the liner is rugged and withstands much rough handling. Case histories of jobs in Nebraska are described, and it is concluded that the liner's versatility makes it a valuable aid in many production and workover problems, such as: (1) isolating thief zones in water flood injection wells; (2) selective acidizing or fracturing specific sections of long perforated intervals, or multiple zone wells; and (3) selectively squeeze cementing multiple zone wells. C. A. F.

1485. Some special properties of oil and gas reservoirs. P. N. Maximov. *Nafta* (*Krakow*), 1958, **14**, 222–4. First appeared in *Geologya Nyeftii*, 1957.—Quantitative relationship in reservoirs and their location described here refer to gas and oil found in the Timan–Pyechorskii area, between Urals and Timan. The central parts of the folds which are exposed show Middle Carbonaceous deposits, while the wings are of

Upper Carbonaceous, and Lower and Upper Permian. Productive horizons are at 850–1150 m in Devonian. They are of gaseous centres and liq (crude oil) around them. They are thought to be of lense-shaped constal deposits. Many surprising developments followed the original drilling plan, which had to be altered. Original inaccurate and final correct distribution of oil-bearing sands are given. The most likely explanation put forward is that the crude was at elevated temp dissolved in the formation gas, and condensation of crude took place after tectonic changes. Thus faulting did not affect it.
M. S.

1486. Study of pressure build-up curves for under-saturated crudes, taking note of the well volume: graphical method of interpretation. II. Determination of skin effect. (In French.) Anon. *Rev. Inst. franç. Pétrole*, 1961, **16**, 275–91.—Computations have been made for functions involving reduced time and reduced pressure for various values of the coeff of the skin effect, and a coeff dependent on well vol, sand thickness, porosity, and well radius. These constitute a basis for the graphical method for obtaining permeability, reservoir pressure, coeff of skin effect, and drainage radius. Three examples are discussed. G. D. H.

1487. Oil production in Hungary. (In Serbo-Croat.) V. Aksia. *Nafta (Yugoslavia)*, 1960, **11**, 169–77.—The Hungarian oil industry, which is 22 years old and produced 1,050,000 tons in 1959, is the eighth largest in Europe. Exploration took place during the first 20 years of this century. In 22 years *ca* 15 million tons of oil have been produced. This article, besides a brief historical review of oil production development in Hungary, also gives a geological and geophysical review of the country, a list of oil and gas reservoirs, and a description of the main reservoirs with maps and cross-sections. At the end the classification of the reservoirs is shown. The main oil reservoirs are Nagylengyel, Lovaszi, and Budafapuszta, which provide *ca* 90% of oil production. The oil strata are, in general, of Pliocene age (Lower Parron), except the Nagylengyel reservoir and some smaller ones, where the oil is situated in the Creda and Trias limestone. The reservoir rocks of Pliocene reservoirs are sandstone and sands. In oil production the secondary methods are applied (gas repressing and water flooding). There has been an increase in oil production. Gas production has been relatively low until now. However, due to the discovery of new reservoirs (Hajduszoboszlo and Pusztaföldran) during the last few years, it will be increased considerably, for there are rich reserves.
(Author's abstract).

OILFIELD DEVELOPMENT

1488. Deeper gas pays spur Arkoma Basin activity. J. A. Kornfeld. *World Oil*, 1.8.61, **153** (2), 94.—There is active gas development in the Arkoma Basin in SE Oklahoma and W Arkansas. Over 7 million acres are now under lease and a big-inch natural gas line is to be built in the basin during next year. Geology and developments in Arkoma are reviewed; there are now 46 rigs operating in an area of more than 9000 sq miles which contains Palæozoic sediments. Deep drilling in recent months has led to the finding of major gas fields at Kinta, Redoak (Norris), Wilburton, Quinton, Rock Island, and Cartersville. A tectonic map of the basin is included.
C. A. F.

1489. Natural gas utilization to begin in S Sumatra. H. P. Dunn. *World Oil*, 1.8.61, **153** (2), 99.—Natural gas in the Radja oilfield near Palembang, Sumatra, is to be used in a fertilizer plant as part of a scheme to increase the petrochemical industry in Indonesia. The field was discovered in 1940 and is located on the crest of an anticline which contains 59 reservoirs from 5400 to 7400 ft deep. 31 producers had been drilled to the end of 1960, of which 17 were producing 1100 bd. Main pay is the Tertiary E sand, but gas for the plant will come from the Telisa limestone at *ca* 5700 ft. This is a medium porosity limestone with average permeability of 70 mD. C. A. F.

1490. U.S.S.R.'s oil industry. (In Serbo-Croat.) V. Aksin. *Nafta (Yugoslavia)*, 1961, **12**, 9–21.—The U.S.S.R. oil industry is one of the biggest in the world. It has been greatly developed since the second world war, and especially in the last few years. The article covers, in outline, data on development and prospects of the U.S.S.R. oil industry. The most important oil- and gas-bearing regions are described. Data on the development of exploration and production of oil and gas are given, and the main oil and gas reservoirs are enumerated. Detailed data are given on the development of drilling techniques in the U.S.S.R., with a special review of turbo-drilling. Extra space is devoted to a short review of transport development, as well as to oil and gas refining. The basic data on consumption and export of oil and its derivates are given. A large number of tabular reviews illustrate the major U.S.S.R. oil industry data. In general, the article is written on the basis of Soviet data from technical and economic literature.
(Author's abstract.)

1491. A formula for oil finding. Pt 1. E. A. Koester. *Oil Gas J.*, 19.6.61, **59** (25), 162.—Factors determining success or failure in oil exploration are analysed from a study of the results and techniques of a representative group of U.S. companies operating in Kansas over a period of 37 years. A similar study was made in 1941 and 1948, and data revised to the beginning of 1960 show that methods for successful oil finding have changed little over a period of 19 years. Tables show lease holdings, daily production, and acreage factors, 1941, and an analysis of exploration policies of companies grouped by acreage factors. The analysis was based on: (1) the size and type of acreage holdings and their proximity to current activity; (2) the relative use of various exploration tools; (3) the dependence placed on local staff in the programme; (4) the relative willingness to support exploration by others; and (5) the initiative of each company. C. A. F.

1492. Modern well completion series. 13. Hydraulic fracturing. W. E. Hassebroek and C. D. Saunders. *Petrol. Engr*, July 1961, **33** (7), B55.—The importance of hydraulic fracturing in the oil industry is reviewed. There are discussions on fracturing fluids, fluid loss, multiple fractures, hydraulic packings for sand control, and on general aspects, such as injection rate. The selection of the fluid and the propping agents is dealt with. Finally, mention is made of the design of fracture treatments and hp requirements. G. D. F.

1493. In water flooding, big capacity pumps solve excessive water problem. E. A. Riley. *Petrol. Engr*, July 1961, **33** (7), B40.—Profits from a water flood project may disappear when large vol of water must be produced to recover oil. In this case, the economics of the operation become important. It is shown that, in certain circumstances, the submersible pump and the hydraulic pump become competitive with the beam pump. Certain case histories are reviewed. G. D. F.

1494. How to locate reservoir limits. J. E. Cornett. *Petrol. Engr*, July 1961, **33** (7), B19.—A method of evaluating reservoir conditions is present. A test is run at constant rate, and the bottom-hole pressure is measured and plotted on semi-log paper as a function of time. The analysis of the draw-down curves produced in this way is discussed; much useful information can be deduced, including the shape of the reservoir, proved in-place oil or gas, orientation of producing capacity, etc. A nomograph is presented to assist in determining the duration of test required to prove a specified number of acres.
G. D. F.

TRANSPORT AND STORAGE

1495. How Sun Oil Co mines and operates LPG storage caverns. P. Dougherty and C. J. Fenix. *Oil Gas J.*, 22.5.61, **59** (21), 88–90.—Sun Oil Co has three underground caverns in granite formations at the Marcus Hook refinery in Pennsylvania. The cost of their construction is only a fraction of that of steel tank storage, and maintenance and operating costs are lower. The depth of underground cavern offers added protection from weather, fire, and explosion hazards.

The method of construction and operation of these caverns are detailed. Sun take light petroleum hydrocarbons under pressure directly from refinery units to storage and use deep-well pumps for recovery. After two years operation of the first cavern no problems have been reported. Butane is metered in and out with turbine meters having an accuracy of $\pm 0{\cdot}05\%$, and no losses have been experienced. A. D. S.

1496. Liquid fuel tanks. (In Polish.) P. Lipka. *Nafta (Krakow)*, 1958, **14**, 219–22.—Remarking on the developments in the field of tank construction, the author quotes from " New Reinforced Concrete Tanks for White Products " (by S. I. Idashkin) which appeared in *Nyeft. Khoz.* A description of the various types of concrete tanks is given. One is 2·7 million l capacity, 28·5 m dia, capable of resisting pressure of 4000 mm (H_2O). This has a supporting pillar in the centre. Another is of French design by Freycine, and there are two variants of tanks without central supports. Details of waterproofing are given. M. S.

1497. Key stop loading. R. C. Reilly. *Pipe Line News*, May 1961, **33** (5), 31.—The term " key stop loading " is applied to any loading facility which allows customers to load their own trucks without supervision of the facility operator. Phillips Pipe Line Co has been operating a loading station of this kind in Oklahoma, and the paper describes the control and operation of the station. M. F. M.

1498. Static storage of liquid methane. C. I. Kelly. *Petrol. Times*, 5.5.61, **65**, 303–6.—The storage of liq methane in static tanks is traced through the period 1939–54. Several problems, including the effect of expansions and contractions of the tank on the insulating material, are discussed.

Three types of storage tank designed to eliminate these problems, together with their mode of operation, are described. These containers rest on concrete mats, supported by concrete pillars, so that air can move freely underneath and thus prevent the ground from freezing and breaking up. The erected cost is estimated at *ca* 24*d*/therm of liq methane storable in units of this type. A. D. S.

1499. Economic factors of pipeline operation. J. D. Graham. *Petroleum, Lond.*, 1961, **24**, 307.—The advantages and disadvantages of pipeline transport are considered briefly, and the paper passes on to a treatment of the economics of the problem. It is stated that, as a rule, it is not worthwhile to build pipelines to carry less than 300,000 tons pa or over less than *ca* 70 miles. Problems arising in multi-product pipelines are also discussed. G. D. F.

1500. Pipeline costs: installation and equipment. J. P. O'Donnell. *Oil Gas J.*, 26.6.61, **59** (26), 139–52.—Since 1953, oil pipelines have increased efficiency, as measured by productivity per employee, more than 50%. Despite this vast improvement, their return per unit of volume has not changed. Net incomes of gas pipelines have been rising steadily, but at a slower rate than their investment. These trends explain why pipeline companies are becoming increasingly cost conscious.

Six sets of tables review many pipeline costs as they apply to construction: (1) current pipeline costs; (2) complete compressor station costs; (3) yearly changes in pipeline cost; (4) estimated current compressor station costs; (5) variations in compressor station costs; and (6) individual pipeline projects. A. D. S.

1501. Self-adjusting pig cleans dual-size line. Anon. *Oil Gas J.*, 3.7.61, **59** (27), 148.—Both dirt and water can be removed effectively from a dual-size pipeline by means of a self-adjusting pig of radical design. In its initial design, the pig was equipped with both front and rear sealing elements using a unique Siamese-twin type flap. Cleaning elements are T-type triangular brushes mounted on arch springs. A subsequent design change has made it possible to substitute rollers for brushes when the pig is used solely for removal of liq. The average life with rollers is *ca* 300 miles per set of flaps. A. D. S.

1502. Saharan natural gas: which way to cross? Anon. *Petroleum, Lond.*, 1961, **24**, 252.—Various routes for carrying the Saharan natural gas pipelines to Europe are considered; (1) by way of Gibraltar; (2) by way of Cartagena; (3) by way of Sicily and Italy. Technical surveys on the various routes have been carried out. The companies involved are mentioned. G. D. F.

1503. Hassi R'Mel–Arzew gas pipeline. Anon. *Petroleum, Lond.*, 1961, **24**, 251.—The Hassi R'Mel gas field in the Sahara is stated to have reserves of 70,000 million cu ft, the composition of which is given. The main pipeline (24 in dia, 313 miles long) from Hassi R'Mel to Arzew on the coast came into operation recently; branches will supply Algiers and Oran. The line is described in some detail, together with plans for future developments. G. D. F.

1504. Soviet oil pipeline pattern to 1965. Anon. *Times Rev. Ind.*, 1961, **15** (175), 57.—By 1965 30,000 km, transporting all crude and *ca* 40% of products. Dia up to 39 inches, oil speed for all lines *ca* 4 km/hr. 1965 output 230/240 million tons, exportable surplus 40/50 million. Map. V. B.

1505. Horizontal gas engine driven compressor unit. J. Lehman. *Pipe Line News*, May 1961, **33** (5), 18.—The paper describes in some detail the use of push button control in connexion with the Cooper–Bessemer, type 22, twin tandem double acting horizontal 1000-hp engine at the compressor station near Corwin in Kansas. The system, which is the first of its kind, is unique, since all operations are performed by a pneumatic system and one man could virtually operate the station. The system was started initially in Oct 1960 and has functioned satisfactorily to date. M. F. M.

1506. Flow control of various oil products in pipeline by gamma densitometer. (In Polish.) Z. Zakrocki. *Nafta (Krakow)*, 1958, **14**, 226.—This is based on a paper by A. A. Akhromyenkov *et al.*, first published in *Nyeft. Khoz.* When various hydrocarbons pass through a pipeline mixing takes place to the extent of $\frac{1}{2}$–$1\frac{1}{2}\%$ of pipeline capacity. Previously gravimetric control was employed. To-day triphenyl stybnine (using Sb-124) can be used or density estimation through opacity to γ radiation. The second method is safer and easier. This type of equipment of Soviet construction has been used in the Groznyi–Trudovaya pipeline. Its particulars are as follows: Co-60 source is located in lead holder. Thalium-activated KI scintillation counter and photo-amplifier are on the opposite side of the pipe. In order to avoid relative movement the two are clamped. Intensity is cut down according to density of the fluid passing through the pipeline. The Groznyi–Trudovaya pipeline is 880 km long and carries gasoline, kerosine, and diesel fuel (densities:

0·730, 0·840, and 0·870). The equipment is located 425 km from the main station. Accuracy of 0·001 g/cc is attainable, though in practice 0·002 is reached. The apparatus is placed in a small well 2 m deep; the amplifier is 50 m away. It is necessary to warm the amplifier for 30 min. M. S.

1507. Telemetering in the crude oil and oil products pipeline field. J. B. Clossner. *Pipe Line News*, June 1961, **33** (6), 35.—Early uses of telemetering and its development have been traced and the application of telemetering to present needs very briefly discussed. Analogue and digital telemetering methods are compared and the merits of each described. The author believes that as automation continues in the pipeline industry the use of telemetering will become more and more important and the computer control of pipeline systems will become a reality. M. F. M.

REFINERY OPERATIONS

REFINERIES AND AUXILIARY REFINERY PLANT

1508. Sulphur plants in economy packages. H. Grekel, L. V. Kunkel, and R. Mungen. *Oil Gas J.*, 5.6.61, **59** (23), 80–1.—The major components of the package sulphur plants built by Pan American Petroleum Corpn and its licensees include the air blower, the furnace–cooler–condenser, the reactors, and separator–storage drum. Experience to date has indicated a very low operating and maintenance cost. A. D. S.

1509. Process control by weighing. R. L. Tosswill. *Petroleum, Lond.*, 1961, **24**, 259.—Until recently, materials were measured by means of vol or level determinations. The accuracy of such measurements is small in many cases. Load-measuring cells ("loadcells") have been developed so as to enable direct weight measurements to be taken. The operation of the loadcells is outlined, and various applications are suggested, *e.g.* stock-taking, weighing road or rail vehicles, batch control, etc. G. D. F.

1510. Petrochemical expansion is sky-rocketing. R. B. Bizal. *Oil Gas J.*, 22.5.61, **59** (21), 66–9.—This latest construction report shows that more than 120 new plants or expansion programmes are under way or planned in the U.S.A. and Canada. Nearly half the projects involve facilities for basic operations, indicating the extent of oil company participation in this growing field. Aromatic projects (23) lead, followed by polyolefins (15) and olefins (15). At least 12 new rubber plants or expansion programmes are included, and expansion in ammonia continues to climb.

A plant-by-plant list of all projects in both countries is presented. A. D. S.

1511. Planning economical refinery electric power distribution. K. N. Thompson. *Proc. Amer. Petrol. Inst.*, 1959, **39** (3), 342–6.—This paper shows how long-term planning can stretch investment dollars when installing new facilities and expanding or modernizing existing electrical distribution systems. The rapid growth in the use of electric power for oil refining justifies such long-range planning to ensure max savings and still cope with the increasingly stringent energy requirements for modern processing units. This trend will continue as crude oil runs increase and the fractions of each oil are handled more times for produce upgrading. Heat and power needs amount to approx one-third of the "cost of refining" crude oil. There is room for economy. The distribution system offers one of the greatest opportunities for savings. Economic factors include the selecting of proper voltage levels, location of load centres, and adequate switchgear installations so that future growth is not hamstrung. A careful plan indicating the nature and timing of future expansions will help avoid the costly short-sightedness so evident when growth studies of existing installations are made. (Author's abstract.)

1512. Are standard procedures the whole answer? J. R. Howard. *Proc. Amer. Petrol. Inst.*, 1959, **39** (3), 502–6.—A typical Texaco plant organization dealing with unit operations is described from the standpoint of the daily efforts made to assure steady, safe, and economical operations. This involves a team effort to develop desirable traits in the personnel, such as close attention to daily orders, detailed knowledge of past experience, good judgment, interest, alertness, and prompt action. These characteristics, of operators in particular, are developed after relatively long periods of time by means of the repeated daily efforts of many individuals and are very difficult to accomplish by standard procedures or operating manuals. Some of the techniques used by these individuals are described in the paper. (Author's abstract.)

1513. Joint refinery-utility installations for electric power, steam, and fuel exchange. E. J. Hess, V. E. Kilpatrick, and G. H. St. Onge. *Proc. Amer. Petrol. Inst.*, 1959, **39** (3), 333–41.—Steam and power facilities represent a substantial part of refinery investment and cost of operation, particularly if the refinery generates electricity. In many situations, an exchange of refinery fuel for electricity and steam produced by a public utility can effect major reductions in refinery investment and operating cost. An energy exchange should be considered in the planning of a grass-roots refinery, a major expansion of steam and power facilities, or when a large-scale replacement of steam and power generating equipment is necessary. Planning must cover the proposed contract terms, investment and operating economies, need for standby facilities, and installation and operating procedures. Since Sept 1957, a fuel–steam–water exchange has been in operation between the Esso Standard Oil Co's Bayway refinery and the Public Service Electric and Gas Co's Linden generating plant. The utility also supplies all the refinery's electric power requirements under a separate agreement. Operating experience to date has been very satisfactory to both parties. The refinery has shut down completely its steam and power generating facilities and maintains no standby generation. Both the refinery and the utility look forward to continued successful operations under the agreements. (Authors' abstract.)

1514. Electric motors in petroleum refineries. L. B. Eddy. *Proc. Amer. Petrol. Inst.*, 1959, **39** (3), 347–54.—Recent changes in the design of electric motors have increased their life expectancy and have improved their general resistance to environmental attack. Of particular importance to the refining industry are innovations in stator insulation systems and protective motor enclosures. Coupled with the hazardous area classifications outlined in API RP500: Recommended Practice for Classification of Areas for Electrical Installations in Petroleum Refineries, these developments have increased the outdoor application of motors which have a minimum of enclosure protection. The trend towards the use of more insulation systems and away from expensive and elaborate motor enclosures should result in definite economies for the petroleum industry. Further developments needed to enhance the reliability and economy of electric motors in refinery service and improved bearings, improved insulation systems, and improved design for the maintenance of clear heat transfer surfaces. (Author's abstract.)

1515. The mathematical simulation of the dynamics of certain processes in fluo-solids apparatus. (In Russian.) V. M. Eliashberg and I. A. Burovol. *Inzh. Fiz. Zhurn.*, July 1961,

4 (7), 96–104.—It is shown that under conditions such that a very large number of vigorously agitated particles occur in a process, as in various fluid–solid operations, the heterogeneous fluid–solid process may be considered homogeneous in certain respects. This fact is used in order to develop a method of simulating the dynamic behaviour of processes involving fluo–solids. Equations are developed for a number of simple cases, and schemes for their simulation are provided by way of an illustration of the general methods proposed. G. D. F.

1516. SSC automatic plant for the cyclic gasification of light cuts. (In Italian.) H. J. Hulme and G. Salvi. *Riv. Combust.*, 1961, **15**, 31–9.—The authors report on the criteria followed in developing and building the automatic and safety system on the cyclic gasification plant for processing light cuts (methane, LPG, refinery gases, straight light dist), designed at the Stazione Sperimentale per i Combustibili. The requirements which the system had to meet are described, as well as the methods of control employed. In particular, the in-line operations of the automatic processing units are illustrated, showing the extreme flexibility and safety of the equipment in question. (Authors' abstract.)

1517. Cleaning and descaling by high pressure water jets. (In French.) R. Peres. *Bull. Ass. franç. Tech. Pétrole*, 1961, 389–406.—Water jets at 60 kg/cm² can be used for cleaning, etc., of vessels such as rail tankers, tanks, drums, plant units, etc. Especially applicable to dangerous locations (*e.g.* those containing TEL). Illustr. V. B.

DISTILLATION

1518. Rotation columns and other types of construction for rectification at pressures of 20 to 1 torr. (In German.) F. Neumann. *Chem. Ing. Tech.*, 1961, **33**, 485–91.—For low absolute pressures, normal dist equipment cannot be used because of too large a pressure drop or too low efficiency, and specially constructed equipment is necessary. Various special types of column are mentioned, *e.g.* film columns, swept-film columns, packed columns, spray columns, etc. Finally, the major part of the paper is concerned with the construction and operating data of a rotating column of the Kirschbaum–Stora system, which has a pressure drop of less than 0·1 mm Hg/tray. G. D. F.

1519. Distillation in view of modern developments. Pt 3. Mass transfer. Chap 1. Mass transfer. K. F. Gordon and J. A. Davies. *Petrol. Engr*, July 1961, **33** (7), C7.—Mass transfer correlations and the assumptions made in deriving them are discussed. Sections deal with gas phase diffusion; liq phase diffusion; overall diffusion (including such matters as the factors which determine the controlling film, transfer units, etc.); efficiencies are dealt with in some detail. The relationship between point and Murphree efficiencies is considered under conditions of perfect mixing, plug flow, partial mixing, together with entrainment corrections. The implications of the various assumptions and limitations are clearly pointed out. 14 refs. G. D. F.

1520. Computers in distillation dynamics research. J. E. Rijnsdorp. *Birmingham Univ. Chem. Engr*, 1961, **12** (Symposium Supplement), S14–29.—The static behaviour of controlled dist columns is discussed, after which the paper considers the use of computers (analogue and digital) in research on the dynamic behaviour and control of dist columns. If linearity be assumed, the differential equations describing the dynamic behaviour of dist columns can be converted to algebraic equations; for this case, theory and experiment are compared. Responses to reboil heat variations are discussed, including some interesting aspects. For columns with many trays, groups of trays can be lumped together to simplify the problem, and the errors in doing this are considered. High-frequency dynamics for multi-component mixtures are also discussed. G. D. F.

ABSORPTION AND ADSORPTION

1521. Regenerating zeolites used for sulphur removal. H. W. Haines, Jr, G. A. Wielingen, and F. B. Mathews. *Oil Gas J.*, 22.5.61, **59** (21), 78–80.—A new adsorption process—the Haines process—for desulphurization and sulphur recovery, which employs alkali-metal aluminosilicates, is being developed in Canada for commercial use. These zeolites are excellent Claus cat and have high equilibrium capacities for water vapour, carbon dioxide, and hydrogen sulphide. These properties permit simultaneous dehydration and sweetening of natural gas and direct conversion of the adsorbed hydrogen sulphide to sulphur.

The process is similar to those used in short-cycle hydrocarbon recovery units, but uses a new type of regeneration cycle. It does not use sweet natural gas as a thermal source for regeneration of the adsorbent. Instead sulphur burner gases containing sulphur dioxide, for the production of sulphur vapour, or oxygen-containing gases for production of sulphur dioxide can be employed.

A thermodynamic analysis is presented to show the feasibility of cost regeneration with air, sulphur-burner gases containing 100% excess air, and sulphur-burner gases containing 3% oxygen, and dilute air burn-off. A. D. S.

1522. 99·6% pentanes-plus recovery obtained with short cycle adsoption. G. F. Russell. *World Oil*, July 1961, **153** (1), 48.—A short cycle hydrocarbon recovery unit has recently been built in the Driscoll field, Texas. It recovers 99·6% of the pentane-plus fraction from a natural gas stream with a gasoline content of only 0·100 gal/1000 cu ft. The unit automatically uses steam and hot gas to regenerate adsorbent beds of activated carbon and alumina. Details of the unit are given with a flow diagram which shows the combination hot gas–steam regenerating system. The unit uses a three-adsorber tower system, so that, whilst one vessel is on stream, the second is cooling and the third heating. Water vapour from the incoming gas stream is used as feed for the steam regeneration system. Operation of the unit is controlled by a time-cycle device set at the desired cycle phase for a given flow rate. C. A. F.

SOLVENT EXTRACTION AND DEWAXING

1523. Experiments on liquid–liquid extraction in spray columns. (In Italian.) G. Astarita. *Chim. e Industr.*, 1961, **43**, 10–16.—Experimental data have been collected on the mass transfer kinetics in both liq phases during an extraction process, by means of a 3·0 cm oil spray column. Dispersed phase flow rates ranged from 0·1 to 1·4 cm³/sec; continuous phase flow rates ranged from 0·2 to 8·0 cm³/sec. The partially miscible binary system water–*n*-butyl alcohol has been chosen for the experiments. The behaviour of the various parameters, namely, specific interface surface, dispersed and continuous phase mass transfer resistance, has been determined as a function of both big flow rates. The results obtained were in good agreement with the hypothesis proposed as to the possible mechanism of the overall phenomenon. (Author's abstract.)

CRACKING

1524. How to predict contaminant coke yield. H. R. Crane, J. E. Connor, and G. P. Masologites. *Oil Gas J.*, 5.6.61, **59** (23), 71–6.—Contaminant coke is defined as the material produced as a result of metal poisons on the cat. Lab studies in which the contaminants are synthetically deposited have given some information, but the results show a much poorer product distribution than cat naturally contaminated to the same metals content in a cracking unit.

In this study many of the experimental data were obtained in the lab using 13% alumina synthetic cat and the Atlantic D & L test. A 12-min oil-cracking period is used, charging 2 ml/min over 200 g pelleted cat in a fixed bed, at 900° F and atm pressure. The factors which control the formation of contaminant coke—feed properties, cat residence time in the reaction zone, cat surface area, metal concn, and the number of cycles of regeneration that the metals have undergone—are discussed in terms of the test results. A. D. S.

1525. New data on Isocracking. J. A. Robbers, N. J. Patterson, and W. T. Lane. *Oil Gas J.*, 19.6.61, **59** (25), 112–13.—Isocracking is the first of the new hydrocracking processes to be placed in commercial operation. The 1000-bd unit at Standard Oil Co of California's Richmond refinery has now been operating for almost two years. Significant developments which have occurred during the past year are: the extension of the dist range of the fuel stock from heavy cracked gas oil to include heavy cat cycle oil and heavy California straight run gas oil. Isocracking of these heavier feeds shows the flexibility of the process to produce low fl pt jet fuel as well as gasoline. Pay-out for a 7000-brl Isocracker, after taxes, is estimated at 2·6 years. It was 3·3 years when similar studies were made a year ago. Pay-out in a comparable situation for cat cracking is 5·8–7·4 years.

Full tabulated details are given of feedstocks, products, and operating costs. A. D. S.

HYDROGENATION

1526. Development of specific catalyst for the controlled hydrogenation of lubricating oils. (In French.) J. Demeester. *Bull. Ass. franç. Tech. Pétrole*, 1961, 5–38.—Cat assessment trials, based on two Kuwait lubricating oils. 46 VI dewaxed (−24° C pour) dist (16 cS/50° C) and 97 VI propane-deasphalted furfural-extracted dewaxed bright stock (34 cS/100° C). Oil stability assessed by ratio of initial colour to that after aging (16 hr, stagnant, 85° C). Trials in lab pilot plants (max cat capacity 1 l), standard conditions 20 kg/cm², oil: 1 vol/vol cat/hr, H_2: 25 vol/vol cat/hr; up to 350° C. Study of effect of varying temp, pressure, spatial velocities. Oil can be stabilized and bleached under conditions (<250° C) which do not desulphurize and hence retain S-containing natural inhibitors; S-removal progressively increases above 250° C. From numerous trials (including tests on some other oils, *e.g.* 24 VI Tia Juana dist, 14·7 cS/50° C, −30° C pour) optimum cat found to be 10% MoO_3, 3·3% CoO, 15% Fe_2O_3, on Al_2O_3. Last must be activated material of well-defined structure. MoO_3 is active base of cat, Fe and Co oxides being promoters. Cat is prepared by impregnation, not co-precipitation. Up to 10,000 vol oil/vol cat can be processed without loss of activity, regeneration is simple. Temp for non solvent-extracted oils is 250°–290° C, for solvent extracted oils high spatial velocities (up to 5 vol/vol/hr) and lower temp (<200° C) give noticeable stable colour improvement. V. B.

ALKYLATION

1527. Modern HF alkylation unit solves surplus butane problem. A. Hegarty. *Petroleum, Lond.*, 1961, **24**, 311.—A recently-completed hydrofluoric acid alkylation unit at the refinery of the British American Oil Co at Clarkson, Ontario, is discussed. This plant has the object of utilizing surplus butanes by alkylating these using HF cat to *iso*-octane. The plant flow, process statistics, and equipment are described, together with the safety precautions in handling the hydrofluoric acid. G. D. F.

ISOMERIZATION

1528. Pure's new butane isomerization process. H. O. Filkins and E. L. Miller. *Oil Gas J.*, 26.6.61, **59** (26), 162–6.—A new process, "Butomerate," developed by Pure Oil Co, complements the pentane–hexane Isomerate process for upgrading light hydrocarbon fractions into high-performance gasoline blending stocks. This process is centred around a new solid cat which has high isomerization activity at low temp. It operates most efficiently in the 300°–500° F range, where no thermal or cat degradation reactions occur with the build-up of coke. The cat is sensitive to large amounts of water and sulphur. Whilst the effect of water is transient, sulphur in large quantities poisons the cat. The superior activity of this process permits operation at reasonable space velocities and this, coupled with the relatively low initial cost and long life of the cat, makes the reactor stage of the process a minor fraction of the cost of a commercial installation. Since the feed preparation, recovery, and recycle operation follow along conventional lines, the capital investment and operating expenses for this part of the process are comparable with other alkylation and isomerization processes. The fact that the process operates at lower than usual hydrogen recycle rates affords a premium in savings in capital investments in the sizes of towers, compressors, etc. A. D. S.

CHEMICAL AND PHYSICAL REFINING

1529. Shell process for desulphurization of petroleum fractions by hydrogenation. (In French.) G. H. Visser. *Bull. Ass. franç. Tech. Pétrole*, 1961, 371–85.—Fundamental reactions; plant description; process development; process characteristics (cat, space velocity, temp, pressure, recycle ratio); cat life and regeneration; commercial application; economic aspects. V. B.

1530. Low-sulphur benzene. W. M. Hyslop, W. A. P. Carter, and E. Marsden. *Industr. Chem.*, 1961, **37**, 331–4.—Investigation of conventional acid-washing procedure for thiophene removal from benzole revealed that considerable reduction in thiophene content could be achieved by using 98% instead of 95% H_2SO_4 and carefully controlling washing time at each stage. Crude benzole containing 5000–6000 ppm of thiophene was treated with 2·7% v/v of 98% H_2SO_4 for 6 hr, 1·35% for 30 min, and 1·35% for 10 min, yielding product containing 0·5 ppm of thiophene. Absorptiometric methods are used for measuring these low S contents; purity of reagents and cleanliness of apparatus are important. W. A. M.

SPECIAL PROCESSES

1531. Recent developments in sweetening hydrocarbons. P. W. Sherwood. *Petroleum, Lond.*, 1961, **24**, 267.—Elimination of sulphur in all forms can be effected almost completely by hydrogenation, but for this low-cost hydrogen must be available. Several recent important developments in the field of sweetening are discussed, including sweetening in caustic media (air solutizer process, inhibitor sweetening, ethylene oxide sweetening, use of sulphur dyes, various methods of caustic regeneration), sweetening in acid media, and sweetening by adsorptive and cat methods. G. D. F.

1532. Let glycols help inhibit hydrate formation. Pt 1. J. L. Arnold and R. L. Pearce. *Oil Gas J.*, 19.6.61, **59** (25), 92–5.—The selection of the right glycol, injection rate, and concn to give good inhibition in low-temp units is discussed. The operation of a low-temp separator using glycol injection is outlined, and the two factors—pump circulating capacity and nozzle design—affecting the final selection of a suitable or practical injection rate are considered. Pointers are also given to prevent or correct common operating troubles.

The choice of which glycol to use depends to a large extent on the gas composition. If glycol is to be injected into a line transporting natural gas only, ethylene glycol is the most logical choice. In gas-dehydration equipment, on the other

hand, ethylene glycol is not practical because of its high vapour pressure, and diethylene or triethylene glycols are more suited to the job. A. D. S.

1533. Separation of Fe, Co, and Ni thiocyanates by furfural extraction. (In Italian.) E. S. Marchetti and M. J. C. Mazza. *Chim. e Industr.*, 1961, **43**, 133–6.—The separation of Fe, Co, and Ni has been achieved by extraction of the thiocyanic complexes with furfural. Partition coeff have been determined for varying metal concn and for varying alkaline thiocyanate excess. For Fe and Co high partition constants have been obtained (higher for Fe), also with low thiocyanate concn; lower values have been obtained for Ni. The separation of Ni from Fe and Co will be therefore easier than the separation of the latter two elements. Experiments on distribution and on countercurrent extraction confirmed the above hypothesis. Co–Fe separation is however possible by varying the thiocyanate excess or the ratio of the two metals. (Authors' abstract.)

1534. SSC thermocatalytic cyclic process for the production of town gas from light cuts. (In Italian.) C. Padovani and G. Salvi. *Riv. Combust.*, 1961, **15**, 5–30.—For some time research has been proceeding at the Stazione Sperimentale per i Combustibili on the production of town gas from light cuts, with both autothermic and endothermic processes. The latter were based on continuous and cyclic techniques. This article describes the way in which the research in question was undertaken and the work done to identify the necessary parameters for designing industrial plant. Mention is made of the straight light dist (SLD) used in Italy, which, having a far wider range of dist than those used elsewhere in Europe, and being denatured with fuel oil, raise some problems when employed for purposes of gasification. The results of the pilot plant run at the SSC and of the first industrial plants are also submitted. The composition and characteristics of the gas, with the relative yields and consumptions, are also given. Some details are given of research performed on making the cat employed in cyclic reforming of light cuts, and in the reactions which occur at high temp between the cat components. Information is given on the expedients to be adopted for proper running of the plant and keeping the cat at full efficiency. (Authors' abstract.)

1535. Proabd refiner. J. G. D. Molinari. *Industr. Chem.*, 1961, **37**, 323–6.—Description of process for production of high purity $C_{10}H_8$ by zone melting. Crude liq $C_{10}H_8$, conc by conventional methods, is fed to a vessel sectioned by multiple heat exchanger tubes, through which water is circulated. Temp is allowed to fall very slowly to 20° C below mp of $C_{10}H_8$. By injecting LP steam temp is slowly raised, and impure $C_{10}H_8$ is run off through the outlet for re-concn. At a given temp just below mp (established empirically) outlet is closed and vessel contents liquefied by rapid heating to give pure liq $C_{10}H_8$ for phthalic anhydride production. Process has been extended to production of nitration grade and chemically pure C_6H_6 from crude benzole, refrigeration being necessary in this instance. W. A. M.

1536. Hydrogen from oil. H. G. Klinkert. *Chem. & Ind.*, 1961, 1381–5.—Description, with tabulated results, of process for production of synthesis gas by partial oxidn of petroleum feedstock with O_2 at 2300°–2700° F and pressures up to 750 psi; feedstocks range from gases to heavy fuel oils. Steam, produced in waste heat boiler, is used as a moderator. C produced is removed from synthesis gas by two-stage water wash. W. A. M.

METERING AND CONTROL

1537. Instrumentation, controls, and automation. 7. Telemetering. M. T. Nigh. *Petrol. Engr*, July 1961, **33** (7), D22.—This brief part concerns itself with two methods of checking the validity of telemetered information, namely, the methods of three-out-of-five parity checks and redundancy. G. D. F.

1538. Analytical instrumentation for process control. Anon. *Petroleum, Lond.*, 1961, **24**, 299.—Abstracts are given of four papers presented at a recent symposium on analytical instrumentation for process control held by Elliott Brothers (London) Ltd on 13–14 June. The abstracts deal with "Analytical Instruments and their Application to Continuous Processes in the U.S.A.," "Experience with Plant Stream Analysis at I.C.I., Billingham," "The Process Stream Analyser—to a User," and "A Survey of Moisture Measuring Instruments." G. D. F.

PRODUCTS

CHEMISTRY AND PHYSICS

1539. Application of the method of similarity to the study of the heat conduction of liquid fuels. (In Russian.) V. B. Zenkevich. *Inzh. Fiz. Zhurn.*, July 1961, **4** (7), 35–9.—A modification of the principle of corresponding states has been applied for correlating data on the heat conductivity of low visc fuels, seven of which are considered. The analysis presented shows that a direct proportionality exists between the ratio of visc/heat conductivity and the mol wt of the fuels investigated for corresponding states. G. D. F.

1540. The API balance sheet on properties of hydrocarbons. W. E. Kuhn. *Proc. Amer. Petrol. Inst.*, 1959, **39** (3), 357–432.—To better evaluate the return on the API investment in fundamental research on the properties of hydrocarbons and related materials, this activity is examined by the use of the format of the balance sheet and the financial annual report. The status of the fundamental research programme is reviewed from the standpoint of the nature of the accumulated assets to date and of the present liabilities, or what we still owe to petroleum science. Some of the most significant accomplishments of the year are mentioned. A look into the future presents a picture of the industry's needs in fundamental knowledge in this area, some probabilities for results, and a blueprint of a few of the future plans in this search for knowledge. (Author's abstract.)

1541. Solubility of methane in propane and butane. (In Italian.) G. Salvi and A. Fuimara. *Riv. Combust.*, 1960, **14**, 822–36.—This paper tells about research sponsored by a public gas distributing company, whose plants are fully methane operated. The company wanted to know if it was possible to use LPG tanks (already installed in the plants) to store together methane (natural gas) and LPG, because of the solubility of the gas in LPG. This operation had the purpose of disposing of an extra quantity of gas, which is to be added to the quantity normally supplied by the methane pipe in order to satisfy the extreme demand during winter. For this purpose the systems methane–propane and methane–butane have been investigated in the practical use range of temp and pressure, and the composition of the liq and gaseous phase has been studied in the same range. From a volumetric standpoint it has been noticed that storing natural gas by solution under pressure in butane presents many advantages in comparison with the compression in dry tanks. The need for a large amount of solvents and the unavoidable losses by evaporation during the stripping of methane are the main factors

which can limit the use of this new technique, because of the high Italian price for LPG. (Authors' abstract.)

1542. Thermodynamics of the desulphurization of petroleum. (In Italian.) A. Girelli and L. Burtamacchi. *Riv. Combust.*, 1961, **15**, 121–30.—The article submits thermodynamic data for a number of sulphur cpds of interest to petroleum technology. The equilibrium constants between 298° and 900° K are likewise given for numerous desulphurization (sulphur cpd $\longrightarrow$ alkene + H_2S) and hydrodesulphurization reactions (sulphur cpd + $H_2 \longrightarrow$ alkane + H_2S). From data given in the latest literature the authors have calculated the log K_{eq} of the hydrodesulphurization reactions for the following cpds: 2,3-dethiabutane, 3-thiapentane, 2-thiapentane, 3,4-dithiahexane, 4,5-dithiaoctane. (Author's abstract.)

1543. Formation of polycyclic aromatic hydrocarbons by pyrolysis of simple aliphatic hydrocarbons. 1. E. Burrows and A. J. Lindsey. *Chem. & Ind.*, 1961, 1395.—As pyrolysis temp of CH_4, C_2H_4, C_4H_6, and C_2H_2 is increased, yield of polycyclic aromatic hydrocarbons rises to a max, then falls. In each case C is deposited. Seven refs. W. A. M.

1544. Contribution to the mechanism of aromatization and dehydroisomerization of branched alkanes over chromia–alumina. S. M. Csicsery and H. Pines. *Chem. & Ind.*, 1961, 1398–9.—Using ^{14}C-labelled molecules the aromatization of 2,2,4-trimethylpentane, 2,2-dimethylbutane, and 2,3-dimethylbutane over chromia–alumina cat was studied. Products formed indicated that reaction proceeded through *cyclo*propane and *cyclo*butane type intermediates. Mechanisms are suggested. Eight refs. W. A. M.

ANALYSIS AND TESTING

1545. Analysis of Lacq effluent by infra-red spectrometry. (In French.) A. Lafaix. *Chim. anal.*, 1961, **43**, 238–40.—Spectra recorded of Lacq gas and of each constituent, all at 1 atm total pressure; partial pressure of constituents made up to 1 atm with N_2. This preliminary work indicates suitability of ir for estimation of CH_4, CO_2, C_2H_6, C_3H_8, COS, and (?) H_2S. V. B.

1546. Getting faster analytical results from a petroleum laboratory. E. D. Childs, J. S. Wiberley, and J. B. Rather, Jr. *Proc. Amer. Petrol. Inst.*, 1959, **39** (3), 516–25.—This paper discusses the importance of getting faster analytical results from a petroleum lab. It emphasizes that the value of an analysis is frequently related to the service and that faster analyses generally mean lower lab costs. Steps taken at the author's lab during a period of years to speed up the analytical work without affecting the quality of results are reviewed. The subject is discussed under the following headings: time surveys, sampling, routing of analytical work, application of statistical principles, adoption of instrumental methods, use of short-cut tests and other time-saving suggestions, training, distribution of analytical costs, and organization and supervision. (Authors' abstract.)

1547. Microanalysis of nickel and vanadium in petroleum residues. (In Italian.) G. Arich and G. Costantinides. *Riv. Combust.*, 1960, **14**, 695–716.—In the determination of traces of vanadium and nickel in petroleum residues it is possible to get results which are reproducible in the range $\pm 1{\cdot}4\%$, even when the metal content is not higher than 10 ppm. The analytical methods have been thoroughly studied with regard to all the possible sources of error in each of the tests, from the ashing up to the colorimetric detection. The results of a set of determinations upon seven different raw materials are reported. The samples have been chosen to cover a wide range of values for the V/Ni ratio. (Authors' abstract.)

CRUDE OIL

1548. Keys to the mystery of crude oil. H. M. Smith *et al. Proc. Amer. Petrol. Inst.*, 1959, **39** (3), 433–65.—This paper is a study and evaluation of recent literature on the composition of crude oil to determine the extent and direction of the findings reported as they may contribute to our further understanding of the origin of crude oil. The work of API projects is particularly stressed. There is a brief review of current theories regarding the origin of petroleum to form a background against which to consider the contributions of the research on composition. Then studies are considered on the following: nitrogen cpds, porphyrins, trace elements, and sulphur cpds; hydrocarbons in the gasoline, middle dist, and heavy oil boiling ranges; olefins; aromatics; chromatography; and thermal diffusion. The pertinent facts from various papers in these fields are pointed out in so far as these facts may concern the origin of petroleum, in one way or another. The authors believe that researches in the non-hydrocarbon field of nitrogen and sulphur cpds, for example, have provided, and will continue to provide, many clues helpful in determining the origin of petroleum. New instruments and techniques are also making possible important contributions from studies of hydrocarbons, even in the lub oil range. A great many individual pieces of information which may pertain to the origin of oil are available, and it should become increasingly possible to tie these together so that eventually a theory containing many of these data can be expected.
(Authors' abstract.)

GAS

1549. Calor gas. Newly completed factory at Millbrook, Southampton. Anon. *Fluid Handl.*, 1961, 187–8.—Brief description of company's operations. W. A. M.

ENGINE FUELS

1550. Fuel filter test house. Anon. *Engineer, Lond.*, 1961, **212**, 366–7.—Description of test house and equipment for testing jet fuel filter/water-separators or bulk capacity filters. Contaminants (water and/or solids) can be added from min of 5 and 15 ppm, respectively; flow rate to filters up to 1200 gal/min; circuit diag. H. K.

1551. Progress in motor fuels. (In Italian.) A. Beukers and K. Arter. *Riv. Combust.*, 1960, **14**, 837–60.—A detailed picture is given concerning the relations between fuels and IC engines. Evidence is given about the improved performance characteristics with respect to past years and to the fundamental contribution of the new types of fuels to the present evolution. Special attention is given to the three main fuel properties: anti-knock quality, volatility, engine deposits. With regard to the first property, correlations between standard lab tests and road tests are discussed. Some correlating formulæ, whose parameters are the motor and research number of a gasoline, the research value of an intermediate fraction, and some experimental coeff, which depend on the type of fuel and engine, are also proposed. A correlation is given for the ON as determined in accelerating conditions and as at constant speed condition. An interesting inquiry indicates that in many cases troubles are due to defective regulation of the spark advance. In regard to volatility, vapour lock and ice formation in the throttle are also discussed. This second effect can be avoided by using additives and preheated air. Sludge and varnish formation on different parts of the engines can be avoided by using suitable types of oils and fuels which are free of some active components, such as olefins, diolefins, and phenols. Deposits in the combustion chamber, the amount of which reaches equilibrium after 6400–8000 km, call for a higher ON and may start ignition by surface effect. Many phosphorus organic

cpds are effective for this purpose. The paper ends by noting that the petroleum industry supports research in the engine field to a greater extent than the engine industry itself, and the authors forecast ever-increasing co-operation between the two industries. (Authors' abstract.)

LUBRICANTS

1552. Molybdenum disulphide dry film bonded coatings. H. J. Winch and L. A. Hicks. *Engineer, Lond.*, 1961, **212**, 392–4.—Description of properties, application methods, operation; bonding agents and curing times tabulated. H. K.

1553. Shear stability of motor oils. (In Serbo-Croat.) M. Kolombo. *Nafta (Yugoslavia)*, 1960, **11**, 201–7.—The author discusses mechanical breaking mol of polymers used as VI improvers of motor oils. Tests were performed by pumping the oil under high pressure through a nozzle. The results indicate that all used improvers deteriorate after being exposed to strong mechanical influence, but not all to the same degree. (Author's abstract.)

1554. A decade of progress in motor lubricants. A. L. Lyman and F. W. Kavanagh. *Proc. Amer. Petrol. Inst.*, 1959, **39** (3), 296–316.—Improvements in engine lubricants since 1949 have resulted in substantially lower oil-to-gasoline ratios, increased life of diesel engines and of gasoline engines used in taxi service, and improved gasoline mileage. New and more potent additives will be required in the future to keep pace with expected engine developments, such as turbo-charging of diesel engines and increase in the speed and CR of gasoline engines, and with the expected increase in the proportion of stop-and-go city driving. A view of progress in the development of additive-containing oils since 1949 covers types of additives used in diesel and gasoline engine oils and the mechanism of their action; lub oils for aircraft, two-cycle, natural gas, and miscellaneous engines; multigrade oils; developments in lubricant test methods; API service classifications and oil drain practice recommendations; basic research on the action of detergent additives, corrosion inhibitors, anti-oxidants, VI improvers, and polymeric ashless detergents; and the economic significance of recent improvements. (Authors' abstract.)

1555. Filters for solvent dewaxing of lubricants. (In Polish.) K. Szadkowski. *Nafta (Krakow)*, 1958, **14**, 216–19.—After reviewing principles of dewaxing the article covers the range of filters available from German firms of Krauss-Maffei-Imperial (Munich), Schwermachienenbau Karl Liebknecht (Magdeburg), and Machinenfabrik Buckau R. Wolf (Grevenbroich). M. S.

SPECIAL HYDROCARBON PRODUCTS

1556. Performance assessment of transformer oils. (In Russian.) R. A. Lipshtein, K. I. Ivanov, and A. Ya. Mikhel'son. *Khim. Tekh. Topliv i Masel*, 1961, (7), 63–70.—Bench tests (*cf* Abs. **1263**, 1959), 750 hr in transformers operated at double normal stress, oil temp 95° C, O_2 satd. Oil condition measured by: water-sol acids after 100 hr; time for aq extract to attain 0·014 acidity; total acidity; sludge; tan δ; Cu corrosion; effect on strength of textile and paper insulants. Tests made with 18 oils, produced from various U.S.S.R. crudes by different refining procedures (acid/alkali; phenol; SO_2; H_2), some oils inhibited (Topanol O). Foreign oils (U.K., France) included for comparison. Inspections on new oils (d_{20} 0·850/899; n_D^{20} 1·466/500; tan δ 20° C % <0·01/0·39; S 0/1·0%; $\%C_A$ 0/23·5; oxidn by GOST 981, total acidity 0·02/1·39, sludge 0/0·09). Bench test results tabulated in two groups, oils from low and high S crudes; transformer oils from latter only usable when inhibited, unless H_2 refined. Best U.S.S.R. oils inferior to foreign, latter develop little low mol wt acids in initial period of GOST 981 oxidn, but would be assessed as relatively unstable on basis of GOST 981 14-hr procedure and also IEC 164-hr test. New types of oils should only be released after satisfactory 750-hr bench test. U.S.S.R. spec (GOST 982-56) should be tightened as regards tan δ, sludge; relaxed for acidity after oxidn. Introduction of requirements for: colour, surface tension, group composition, tan δ after lab aging, Cu corrosion, gassing in H_2, is suggested. V. B.

1557. Carbonyl test detects wax odour. M. E. Peterkin and J. W. Laveland. *Oil Gas J.*, 3.7.61, **59** (27), 121–4.—Certain odour-causing cpds in wax make it unsuitable for many applications, such as coating paper, fibre board, and milk cartons. These cpds were removed from the molten wax by bubbling nitrogen through at 275° F, and were condensed for chromatographic examination. They were shown by a carbonyl test to consist of a number of ketones or aldehydes containing seven or fewer carbon atoms in the structure. A study was then made to determine what conditions would be best for colorimetric determination of these odour materials. The coloured complex with 2,4-dinitrophenylhydrazine was developed and determined spectrophotometrically. The " equivalent odour panel rating " from the carbonyl test on 40 different waxes showed a reasonable correlation with an odour rating, based on smell, obtained by a panel of experts.

The present carbonyl test is a step forward, but more information is required, and may be obtained by using more sensitive gas chromatographic techniques and ionization detectors. A. D. S.

1558. Gas absorption of insulating oils. I. Koenig. *Elektrie*, 1961, (5), 166–8.—Distinction drawn between physical absorption (depending on gas solubility and pressure, reversible, and applicable to inert gases such as N_2) and chemical, involving reactive gases (O_2, H_2), irreversible. Owing to surface tension effects, degassing more effective with oil as thin film flowing over flat surface (10^{-3} mm Hg 25°/35° C) rather than as spray. Mechanical agitation of oil facilitates degassing and enables efficiency of low vac (few mm Hg) degassers to be improved. Equipment vibrating at 150 c/s, 250 l/hr, described and illustrated. Chemical gas absorption can be improved by addition of 8-hydroxyquinoline (0·5 g/l). V. B.

DERIVED CHEMICAL PRODUCTS

1559. Preparation of acetylene. Anon. (In French.) *Chim. et. Industr.*, 1961, **85**, 764.—Correction, by licensors of pyrolysis process, *cf* Abs. **218**, 1961.

1560. A decade of progress in petrochemicals. J. H. Forrester. *Proc. Amer. Petrol. Inst.*, 1959, **39** (3), 317–20.—Stated briefly, the petrochemical industry is big and important, has enjoyed a phenomenal growth rate since 1948, and is passing from teenage to adulthood. Petrochemical production at present totals 40 billion lb pa, valued at $5 billion. The important commercial products number 200–300, of which 25–30 constitute the major volume items. Although petrochemicals constitute only 1–2% of total demand for all petroleum products, the dollar value of these products is much greater as petrochemicals than as petroleum fuels and lubricants. Since 1948, petrochemicals have grown at an annual rate of 14%, compared with a 4% rate for petroleum. This has required an investment of $5 billion to $7 billion, and the number of people employed has tripled. The three reasons for this rapid growth are: the displacement of chemical products in existing markets (*e.g.* ethanol from ethylene displacing ethanol from molasses); the introduction of new chemical products (*e.g.* polyethylene); and the release of petrochemical capacity from military use after the second world war (*e.g.* synthetic rubber and ammonia). As to the future, there are

signs that the growth rate of the industry is slowing down. The petrochemical industry will grow only as fast as the market for existing products increases, and new petrochemicals for new uses are brought to market. Emphasis will probably be on the latter. (Author's abstract.)

1561. Global rubber review. Prospects for isoprene: its production from C_4 petroleum fractions. (In French.) A. Giraud. *Bull. Ass. franç. Tech. Pétrole*, 1961, 299–340.—Survey of future course of rubber market; characteristics of various types of synthetic rubbers summarized; assessment of part to be played by polybutadienes and polyisoprenes. Previous isoprene syntheses briefly reviewed, followed by description of IFP process. Raw materials are methanol (converted to HCHO) and a cut containing *iso*butylene obtained by cat or steam cracking, or by dehydrogenation of *iso*butane (which may be linked with butadiene manufacture). Main technical characteristics of process are described. Isoprene obtained is suitable for polymerization. Economics of process considered, whence it appears that isoprene could compete with butadiene. (Author's summary.)

COAL, SHALE, AND PEAT

1562. Chemism of coking, investigation on polymeric model materials. VIII. Application of the insight obtained to coal. (In German.) D. W. van Krevelen, P. M. G. Wolfs, and H. I. Waterman. *BrennstChemie*, 1959, **40**, 371–7.—Results of an investigation with the help of model materials on coking mechanism, already discussed, can be transferred to coal coking. Analogies are: temp range of decomp and plasticity, selectivity of gas and tar formation, course of coking product composition, and temp/time scheme influence in coking. Important conclusions on coal structure are now possible. Therefore a new formula can be derived for ring-condensation number of the coal structural unit. The average bridge number each mean structural unit amounts to 1–1·3, apparently in the range of bituminous coals. The most important conclusions concern the functional distribution of the elements, especially H_2. Application of the relationship found on model materials leads to remarkably good results, whilst this method gives—when applied to coal—likewise significant results. Ten refs. R. T.

MISCELLANEOUS PRODUCTS

1563. Polycyclic aromatic hydrocarbons in carbon blacks. A. J. Lindsey and M. A. Phillips. *Chem. & Ind.*, 1961, 1171–2.—Examination of U.S. samples of C black for presence of polycyclic aromatics revealed only minute quantities of lower polycyclics and no trace of higher carcinogenic hydrocarbons. *Cf* Abs. **91**, 1959. W. A. M.

CORROSION

1564. Statistics solve an inspection problem. W. P. Shontz. *Oil Gas J.*, 22.5.61, **59** (21), 92–5.—Inspection engineers at Standard Oil Co's Cleveland refinery had a serious problem to consider. Crude-unit furnace-outlet piping on each of twin crude units showed corrosion rates, and on one unit it seemed to be unpredictable. It was decided that, on new piping, a sample would be taken after one year of operation to show whether there was an unpredictable corrosion rate. After four years operation another sample would be taken to verify previous corrosion rates and to predict the time at which the piping should be replaced. In addition, by the use of statistics, inspectors could decide how many data points would be necessary to get the required accuracy for a prediction. Ensuring the required number of data points allows an estimate of the inspection cost. A. D. S.

1565. Coal tar coatings and resin base primers. F. Whittier. *Pipe Line News*, June 1961, **33** (6), 41.—Resin-based gas drying primers for use under coal tar enamels are attracting considerable interest. The proprietary names of these primers are: (1) synthetic primer No. 1122 (Allied Chem Corpn); (2) bitumastic jet-set (Koppers Co); (3) Reilly redhead (Reilly Tar & Chem Corpn); (4) Pitt Chem quick dry (Pittsburgh Chem Co). The results of some tests on bonding properties of resin base primers are given in this paper. M. F. M.

ENGINES AND AUTOMOTIVE EQUIPMENT

1566. Determination of vapour lock with the Sunbury apparatus. (In Italian.) C. Siniramed and I. Torzoni. *Riv. Combust.*, 1961, **15**, 241–62.—All other factors being constant, the formation of vapour lock, which is observed in a gasoline engine's feeders, is an increasing function of the fuel's volatility. In the present paper the different formulæ and lab tests which are used to establish the tendency of a fuel to form vapour lock are examined. Particular attention is given to determining with the Sunbury apparatus the volatility index as a function of temp. With regard to the critical values (full vapour lock), a comparison is reported between the experimental data of the Sunbury apparatus and the theoretical data of the Sunbury formula, which has been developed as a function of parameters which are related to classical volatility measurements.

(Authors' abstract.)

1567. Comparison between injection and carburation in motor engines. (In Italian.) H. Brockhaus, T. F. Casell, and D. M. A. Masterman. *Riv. Combust.*, 1961, **15**, 152–78.—The work reported was undertaken to establish if there were significant differences between the fuel quality requirements of injection engines and those of conventional carburettor engines. A Mercedes 300 SC car, available with a direct cyl injection system, was used. The most important fuel quality requirements of this car on the road were compared with the requirements of the same car after it had been successively converted by the makers to a conventional three-carburettor assembly and to a direct port injection system. Anti-knock requirement tests showed a useful advantage for the direct cyl injection system over either of the alternative arrangements. The difference is somewhat low. The three systems showed a similar tendency to depreciate olefinic fuels at high speeds. At very light loads, and in comparison with the carburettor system, there appeared to be a narrower range of fuel gravities over which either injection system would run satisfactorily without retuning. Carburation gave smooth performance and rational fuel consumption data from 0·69 to 0·82 sq gr. Whereas the port injection system was largely uncritical, the cyl injection system needed fuels of quite high front-end and mid-volatility for satisfactory cold starting performance. The cyl injection system also required good mid-volatility for satisfactory warm-up performance. This work showed that the fuel quality requirements of fuel injection systems differed in some respects from those of carburation. In no case, however, were these differences critical, and it is concluded that fuel injection engines will be satisfied with fuels now available. (Authors' abstract.)

SAFETY PRECAUTIONS

1568. How committee action has reduced Humble's accident rate. J. N. Kayser and R. W. Williams. *Oil Gas J.*, 26.6.61, **59** (26), 178–81.—Humble Oil & Refining Co has found that effective safety cttees make the refinery a safer place to work in. Although these cttees are advisory only, they are effective because they are constituted with experienced and respected men. Their activities are directed along the following general lines. They review start-up, shutdown, and emergency procedures; they review accidents and near accidents; they develop guides for safe handling of flammable materials and review operating problems, engineering design, and plant layouts.

The means of communicating information and impressing on the man who does the work the need for safe practices are considered. A. D. S.

1569. Development of safe procedures. R. C. Steinhoff, Jr. *Proc. Amer. Petrol. Inst.*, 1959, **39** (3), 499–501.—This paper describes three successful types of programme employed by the American Oil Co to develop safer operating procedures. Two of these programmes involved the Texas City refinery only, and one programme was company-wide in scope. The first programme inaugurated at the Texas City refinery was composed of technical people from the various departments who reviewed and recommended changes to equipment which would promote safer operations. The person in charge of the particular facility being studied was responsible for the preparatory work and the discussions which followed. The second Texas City programme involved the hourly top-level operators and all supervisors in the operating department. This was a discussion-type session which prepared answers to approx 600 questions pertaining to operating safety techniques. The company-wide programme consisted of a review and study of various operations in the different refineries, and was conducted in much the same way as the earlier arrangement at the Texas City refinery. Each of the three programmes developed accomplished a specific goal for the company. In each programme the satisfactory results obtained may be attributed to the procedure followed, *i.e.* by having the person who controls the particular operation do the talking, and those who are to make use of the information assist in developing the data. (Author's abstract.)

1570. Safety in process operations. J. J. Coates. *Proc. Amer. Petrol. Inst.*, 1959, **39** (3), 496–8.—This paper discusses in a general way the safety problems that are the concern of the process operator. This point is made that forums of this type serve a useful purpose in providing a means of sharing knowledge and experience in handling operational safety problems. (Author's abstract.)

1571. Protective facilities for refinery process units. W. C. Bluhm. *Proc. Amer. Petrol. Inst.*, 1959, **39** (3), 507–11.—This paper discusses seven types of basic protective facilities commonly installed in refinery process units as a protection against the hazards of fire or other emergencies. These protective devices include: (1) pressure relieving facilities; (2) vapour depressuring systems; (3) big drop-out or blow-down facilities; (4) fire-water systems; (5) water spray and fog systems; (6) structural fireproofing; and (7) miscellaneous aux facilities. Controversial considerations which occur in the selection and design of these facilities are reviewed, and suggestions are made regarding the value of each system as it relates to potential hazards. (Author's abstract.)

ECONOMICS AND MARKETING

1572. Political decisions burden international oil industry. E. Adams. *Petrol. Engr*, July 1961, **33** (7), A13.—The paper commences with a brief review of the impact of recent political trends on the international oil industry. The remainder consists of a review of world oil operations in some 77 countries from the Ivory Coast to Zanzibar (*cf* Abs. **1424**, 1961). G. D. F.

1573. Sasol makes a profit on oil from coal. Anon. *Petroleum, Lond.*, 1961, **24**, 263.—The Sasol plant near Johannesburg is outlined. The process is described in detail, the various units, their operation, constructors, etc., are given. Last year, the corpn made a profit for the first time. Production this year is expected to reach 270,000 short tons of petrol and other products. G. D. F.

1574. Soviet oil exports in 1965 may reach 900,000 bd. I. H. Cram. *Petrol. Engr*, July 1961, **33** (7), A28.—It is shown that the U.S.S.R. moved into second place among the oil producing nations in 1960, with a production of 2,960,000 bd. Extravagance in equipment and personnel in the Soviet oil industry is pointed out. However, the economic dangers of increased Soviet oil exports are real, and will probably increase. G. D. F.

1575. Britain's petrochemicals boom. H. P. Hodge. *Petroleum, Lond.*, 1961, **24**, 301.—The production of organic chemicals in the U.K. between 1949 and 1962 (estimated) is reviewed, and it is shown that petroleum's share as a raw material has risen from 9% (1949) to 47% (1959) and is predicted to rise even further to *ca* 65% (1962). Some of the major items in this large increase are discussed in detail. The various petrochemical producers in the U.K., their interrelations, major plants, and products are discussed with the assistance of tables and diagrams. G. D. F.

1576. Leaders in oil. 2. Royal Dutch/Shell. T. H. H. Skeet. *Petroleum, Lond.*, 1961, **24**, 293.—The history and organization of the Royal Dutch/Shell group of companies are outlined briefly, together with the entry of the group into the U.S.A. and Canada. It is shown that the group production represents *ca* 14% of the free world total. Tables indicate production and exploration interests of the group and the marketing subsidiaries throughout the world. The transport and tanker activities are reviewed, and there are lists giving present Shell refineries, planned new refineries and extensions, and petroleum chemical plants owned or partly owned by the group. G. D. F.

1577. Changing pattern of Austrian oil industry. Anon. *Petroleum, Lond.*, 1961, **24**, 314.—A brief paper shows that oil production in Austria is falling, and discusses the arrangements being made to compensate for this. The refinery position is also reviewed. G. D. F.

1578. European natural gas economics. (In French.) G. de Corval. *Bull. Ass. franç. Tech. Pétrole*, 1961, 409–26.—Lecture with statistical tables and maps. V. B.

1579. Some aspects of the European chemical industry based on petroleum raw materials. H. Hoog. *Chem. & Ind.*, 1961, 1374–80.—Rapid expansion of European petroleum chem industry in recent years is illustrated, and factors governing siting of installations are considered. Effects of interaction of petroleum refining and chem manufacturing industries are discussed. W. A. M.

MISCELLANEOUS

1580. Oil and gas property acquisition. W. Z. Wilson. *J. Petrol. Tech.*, June 1961, **13**, 327–30.—As a consequence of the depressed state of the oil industry, the impact of taxes, and the rising costs of replacing reserves through exploration and development, during the past ten years there has been increasing emphasis on acquiring producing properties by outright purchase. Some operators wish to sell part or all of their oil and gas properties, while others are interested in acquiring properties. Various factors have driven up prices substantially.

Some companies seem to have no systematic programme in these activities, but long-term growth and a reduction in average incremental costs should be the aim. An analysis of the buyer's present operation should be made before searching for properties which will give the desired objectives. Most purchases of this type are financed by the reserved production payment method, which offers advantages to both buyer and seller. Commercial banks and other sources of long-term funds can provide adequate funds for this type of transaction.
G. D. H.

1581. Depletion rationale and recent political pressures of erosion. O. H. Lentz. *J. Petrol. Tech.*, June 1961, **13**, 522–6.—In 1909 the income tax legislation did not distinguish between depletion and depreciation, and in 1913 the Supreme Court rejected the argument that all the proceeds of extractive production constitute a conversion of capital. The original version of the 1913 law provided a cost-depletion basis for minerals, but this was substituted by a 5% limitation on the value of the gross output. In 1916 original cost was used as the limit for depletion allowances. Since the costs of finding oil sometimes exceed the value of the oil discovered the total amount depletable could exceed the value of a new discovery. Discussions in 1918 recognized the special problems of extractive production, and the unique risks. Congress aimed at a tax-free return of capital, and it was hoped to stimulate exploration and allow for indirect costs such as dry holes. There was general agreement that the administration of depletion allowances as " discovery value " was cumbersome, costly, and often inequitable. In 1926 there was a return to percentage depletion at 27½% for oil and gas.

Three weaknesses in the depletion rationale are the rate of depletion for royalty owners, the empirical data for establishing the percentage, and the option to expense intangible drilling and development costs, which may be 50–65% of the total development costs. There is pressure either to reduce current depletion rates or to eliminate the option to expense intangible drilling and development costs. G. D. H.

1582. Vanishing petroleum engineering student. H. G. Botset. *J. Petrol. Tech.*, 1961, **13**, 517–18.—Oil and gas supply 70% of the U.S. energy needs, and the petroleum industry may grow at 2–3% pa for some time. Over half the capital is invested in the production branch. Since the war 20–23 schools have supplied an average of over 550 graduates in petroleum engineering annually. Analysis of enrolment and other data shows that only *ca* half the freshmen complete the course, and that in 1961, 1962, 1963, and 1964 the number of petroleum engineering graduates may be *ca* 600, 340, 230, and 145, respectively. Other types of engineering have had reduced enrolment, so competition for men will be intense. Increased enrolment requires awareness of the achievements of engineering, expenditure of effort, and the co-operation of those who advise students. G. D. H.

1583. New concept of aerial surveying. W. H. Scott. *Pipe Line News*, June 1961, **33** (6), 22.—For the first time a route for a natural gas pipeline has been entirely surveyed by aerial photogrammetry without any visits to the site by the ground crews. This was accomplished for Northern Natural Gas Co and the 80-mile route from Duluth to Silver Bay (U.S.A.) in two days, and the pipeline is now under construction. Aerial surveying proved to be very accurate and economical.
M. F. M.

1584. Russia plans 19,000 miles of new oil line. Anon. *Pipe Line News*, June 1961, **33** (6), 14.—Soviet Union is planning 19,000 miles of new oil lines in the next few years, according to the U.S. Bureau of Mines report " The Soviet Seven-Year Plan for Oil, 1959–1965." Under this plan the U.S.S.R. has allocated 12 billion roubles to expand the country's trunk pipeline system from 9000 miles in 1958 to 28,000 miles by the end of 1965. Crude lines will comprise *ca* 11,000 miles and petroleum product lines 8000 miles. The programme calls for installation of over 100 pumping stations with an aggregate capacity of 1·2 million kW. A map and some details of individual lines are included in the paper. M. F. M.

1585. Weather expectancy—science or clairvoyance? F. C. Roop. *Proc. Amer. Petrol. Inst.*, 1959, **39** (3), 487–94.—The operational use of weather forecasts has remained an intrinsic art because it is difficult to interpret the usually indefinite information presented. The forecaster's expectations are always somewhat uncertain, and the language of forecasts seldom reflects precisely what is likely to happen. There are two main avenues to improve this unsatisfactory situation through fundamental research—first, by statistical study to develop accurate means of stating forecast probabilities for the events which may occur, and, second, by employing principles of physical and synoptic meteorology to analyse and pinpoint more definitely the most probable course of events. In attacking degree-day departures from normal and the cause of development of hurricanes, the API Advisory Cttee on Fundamental Research on Weather Forecasting has followed both of these avenues. The work on degree-days has focused on the accurate specification of probabilities and especially on statistical means of distinguishing those situations where a significant departure from normal can be reliably expected. The work on hurricane development has uncovered hitherto unrecognized synoptic features of the upper air and surface circulation patterns, which appear to exert physical control on the decay or build-up of energy in a tropical storm. Fundamental research oriented to the petroleum industry's weather problems can put weather forecasts in the category of scientifically useful tools. (Author's abstract.)

1586. Purchased power saves $200,000 for Sohio. R. W. Mills. *Proc. Amer. Petrol. Inst.*, 1959, **39** (3), 322–32.—This paper covers the increase of electric power load from 1948 to 1958 and outlines how the electrical sub-stations were increased from a load of 1200 kVA to the new load of 38,000 kVA. This coincides with the increase of crude oil runs and points out that each time the refinery electrical system was expanded it was done with a minimum of dollars. It outlines the close co-operation between the Ohio Power Co and Sohio, which resulted in max reliability at minimum cost. Working closely with the power company, it was possible to attain a low kW-hr cost. Other types of drivers were evaluated along with electricity and the result was lower capital and operating costs for Sohio, using electrical power. (Author's abstract.)

1587. Plant management applications. D. G. Thompson. *Birmingham Univ. Chem. Engr*, 1961, **12** (Symposium Supplement), S11–13.—The paper describes the use made by the Esso Fawley refinery of digital computing facilities to guide management in the fields of: (1) operations planning; (2) investment control; (3) cost control. Among the aspects considered are the applications of digital computing to plant

design, oil movement and storage investment, costing, plant performance analysis, and stores control. The discussion on this paper is reported on pp. 830–33. G. D. F.

1588. Preventive measures against pollutants in the exhaust gas from road vehicles. (In Italian.) A. Fitton. *Riv. Combust.*, 1960, **14**, 717–43.—The emission of pollutants in the exhaust gas from road vehicles is mainly due to incomplete combustion of the fuel in both gasoline and diesel engines. The causes and occurrences of incomplete combustion are discussed, and the various methods which have been adopted to reduce the emission of pollutants are outlined. The first half of the paper is concerned with methods of preventing the formation of pollutants and the second half with reducing the amounts which have been formed. It is stressed in both types of engine that first class maintenance and servicing, control of loading, and good driving techniques are essential in order to reduce the formation of pollutants. Various methods of preventing fuel being fed to a gasoline engine whilst the vehicle is decelerating are described. In extensive road tests carried out on a vehicle fitted with a cat type of after-burner when using leaded gasoline, efficient oxidn of carbon monoxide took place over extended periods. The efficiency of oxidn of the hydrocarbons, however, was materially lower. Information is given on the other types of cat after-burner designed for operation with gasoline engines and on two types designed to operate with diesel engines. Reference is also made to work in which the cat is actually brought into the engine by coating the cyl head and piston with a cat ceramic material. Test results are given for an after-burner which does not employ a cat, but relies upon spark ignition to maintain a stable flame. This apparatus operated satisfactorily with a gasoline engine during idling and decelerating periods in which appreciable combustible materials were present, but was ineffective when the vehicle was cruising or climbing. The advantages and limitations of scrubbing and adsorption in the removal of pollutants are discussed. Finally, the author suggests that a tunnel-type after-burner designed as a small, high-intensity combustion chamber might prove to be suitable for both types of engine. The unit would be built close to the exhaust manifold, and air to complete combustion would be supplied from a small blower. (Author's abstract.)

1589. Use of mineral oils and natural gas in blast furnaces. (In Italian.) A. Scorticci and G. Ortelli. *Riv. Combust.*, 1961, **15**, 40–64.—The article reports on research and results attained, so far, on the use of heavy oil and natural gas to replace metallurgical coke for firing blast furnaces. These hydrocarbons were considered as partly replacing the solid fuel, not for reasons of necessity, but as an economic measure to achieve a saving in costs. Economic, commercial, and sociological considerations prove that Italy, with its moderately sized iron and steel industry and its very large petroleum conversion potential, can replace quite a considerable percentage of coke by fuel oils without encountering appreciable difficulties in supply. For the ECSC member countries, on the contrary, the situation has different aspects, and even assuming that only 50% of the coke was replaced, it would cause a notable increase in crude oil imports. It has also to be borne in mind that a further cut in coal consumption within the Community would aggravate the already very precarious situation of the collieries. Due consideration must therefore be given not only to the purely economic issues but also to the social and political consequences of any such change in the structure of consumption as well. (Authors' abstract.)

1590. Petroleum and natural gas; versatile raw materials and indispensable energy sources of our generation. (In German.) H. Ruf. *Schweiz. Arch. angew. Wiss.*, 1961, **27**, 223–36.—Lecture, with illustrations, tables, graphs.

1591. Dust in gas streams. 2. Instruments for collecting and identifying particles. C. B. Moore, J. R. Ehrenfeld, and N. M. Wiederhorn. *Petrol. Engr*, July 1961, **33** (7), D15.—Instruments used for characterizing particles in gas streams fall conveniently into two types: monitoring instruments and particle collection devices. Monitoring instruments usually determine directly some property of the particles in the stream, and may give a continuous record. Several instruments of this type are described, including light-scattering types, electrostatic counters, electrostatic surface area meters, and hot wire evaporators (liq particles). Particle collection devices include various types of filter, sedimentation and impaction devices, cyclones, and electrostatic precipitators. Finally, instruments for analysis are discussed briefly. 20 refs. G. D. F.

BOOK REVIEWS

Oil in the Middle East. Second Edition. Stephen Longrigg. London, New York, Toronto: Oxford University Press for the Royal Institute of International Affairs, 1961. Pp. xiii + 401. 35*s*.

The present volume is a reprint of one published in 1953 with additional material that extended an acquaintance with Middle Eastern oil affairs to mid-1960. Within the compass of 20 chapters and 400 pages a remarkable and fascinating story of Middle East oil discoveries is vivaciously unfolded. The last six chapters deal with happenings since the publication of the first edition in 1953. Compiled by an experienced and accomplished writer having considerable personal acquaintance with oil matters in that troubled part of the globe, the contents are especially valuable to all associated with the petroleum industry. The addition of 12 maps is of great assistance to readers unacquainted with the Persian Gulf region.

It is abundantly clear that the author had privileged access to documents and information not generally available; but with some personal knowledge of what transpired behind the curtain of publicity it must be conceded that the facts related constitute a fair if cautionary commentary on the contentious and acrimonious international wrangles that attended the allocation of oil rights on the partition of Arabia after the first world war. So great were the demands for oil during the war and so serious was the drain on known reserves in the U.S.A. and elsewhere, that the major oil producers of the world were driven to seek new sources of supply. The lure of extensive blanket concessions, such as were unknown in the U.S.A. and Europe, over territory known to offer the prospects of locating and developing as a unit oilfield structure of great size and prodigious yields attracted all the majors to the Persian Gulf region. Fierce competition for oil rights led to extravagant offers by those seeking unallotted offshore territory and other promising areas not covered by previous grants.

Although surface manifestations of oil were known from time immemorial on the arid southern fringe of the fertile crescent, no one imagined what riches lay beneath the great deserts of Arabia and Persia until a British company, after seven years of disappointments, struck a highly productive well at Masjid-i-Suleiman in 1908. This success was achieved only after an expenditure of much money on a concession acquired in 1901 by W. Knox-D'Arcy covering much of the country. Without the financial and technical aid of the Burmah Oil Company, prospecting would likely have been discontinued. So much official importance was

attached to this new source of oil that the British Government was induced to take a big share interest in the newly formed Anglo-Persian Oil Company. Only by an almost superhuman effort was oil made available at Abadan in 1914 for use during the first world war.

It is shown in subsequent chapters how the Persian success led first to the discovery of oil in Iraq and then in Bahrain, Kuwait, Saudi Arabia, and Qatar, with eventual offshore successes on the continental shelves off the Arabian and Persian coasts. The first 14 chapters deal with events up to 1953, which depict how the conflicting oil interests gradually replaced animosity by friendship and co-operation, and somehow succeeded in overcoming the innumerable and almost insuperable obstacles that confronted them. Quite distinct from the physical difficulties occasioned by an unkind climate and a scarcity of potable water and comestibles was the hostility or contrariness of nomadic tribes, and at a later stage the attitude of avaricious politicians envious of the profits earned by the oil companies. Little thought was given to the many technicians who risked their health and life in cutting a trail across waterless deserts and solving the myriad problems presented in the transport and operation of machinery and plant needed to explore and exploit oil deposits, and arrange for the marketing of oil when found. An exciting account is given of the deplorable, tragic political upheavals which in both Persia and Iraq for a time demoralized an industry which was their main source of revenue. Revolutions, wars, and social upheavals have caused the oil companies grave anxiety, needless expense, and harrowing experiences; and squabbles over payments for pipeline rights of way over adjoining states have been incessant. The Arab–Israel controversy enforced expensive modifications in pipeline and port facilities.

Chapter 14 deals with oil prospecting projects in other Levant countries, where nothing comparable with that of the Persian Gulf region has so far been disclosed, despite the expenditure of vast sums on securing prospecting rights and conducting experimental surveys and drilling prospects.

The last five chapters are devoted to events after 1953, and Chapter 16 describes in detail the working of the consortium that followed the extinction of the Mossadeq regime in Persia. Chapter 17 gives an excellent account of the astounding expansion of Saudi Arabian developments. In Chapter 18 will be found interesting facts concerning the operations in the Arabian Principalities, where large sums have been spent in exploring vast stretches of arid territory with varying degrees of success but often of a negative or unimportant extent. Chapter 19 is concerned with the endeavours of oil groups to find oil in the Levant countries, and the problems that arose from the nationalization of the Suez Canal in November 1956 and the formation of the United Arab Republic in 1958.

Chapter 20 is entitled "Facts and Probabilities," and presents figures and data that demonstrate the stupendous potentialities of Middle Eastern oilfields, which in 1959 produced 228 million tons, about 23·7 per cent of the free world's output. The main producers are Kuwait, Saudi Arabia, Iran, Iraq, Bahrain, and Qatar, which, added to small amounts from Egypt and a few other countries, hold reserves estimated at 26,000 million tons. This figure has since been greatly increased by offshore developments in the Persian Gulf. It is remarked how these results have converted some of the most indigent nations of the world into the richest, and how opulence and prosperity have inspired ambitions and objective that overstrained the oil revenues. It is a highly debatable question whether the impact of European ways on a poor and fanatical Islamic population has not fomented conduct more detrimental than beneficial for a healthy revival of modern nationalism. The author appropriately comments on the initial importance of the vast blanket concessions of unmapped deserted lands granted to oil pioneers for prospecting, but also refers to the discontent of rulers who in ignorance made these grants. In order to placate those resenting the presence of so many foreigners and objecting to the liberality with which newcomers have been treated, many concessions have been made, and much territory freed for releasing to others willing to accept more onerous conditions. The author does not conceal the anxiety which he feels about Middle East oil supplies, upon which so much of the world now relies, but he is hopeful that by adopting a spirit of helpfulness and a desire to conciliate those adopting a way of life so different from that of Europeans a peaceful solution will be found. Since the book has been published, events have transpired that render relations more delicate than hitherto by the attitude of Iraq and the landing of a British force to protect Kuwait from invasion.

The author very properly refers to the chaos that might ensue from any attempt to expel the foreigner who has supplied not only the money but also the technical skill that has made possible the exploitation of the oilfields and the treatment and marketing of the oil. A sudden suspension of royalties and payments by the oil companies would lead to unbelievable distress in all the countries now producing on a large scale. Reference is also made to the yearly advance in developing other sources of energy now in progress, such as hydro-electric installations, coal firing, tide utilization, solar radiation, and atomic energy. Any serious curtailment of cheap oil supplies would hasten progress in those directions. Recent oil developments in Russia and the Sahara are likely to further embarrass those engaged in the oil industry.

A. B-T.

Benzoles—Production and Uses. Ed. G. Claxton. London: The National Benzole and Allied Products Association, 1961. Pp. xiii + 979. 105*s*.

The two earlier editions of this volume under the title "Motor Benzole—Its Production and Use" achieved a worldwide reputation as the standard reference book covering the benzole industry. This new publication, the work of several experts in the field of benzole technology, has been revised and rewritten, contains much additional information, and reviews new fields.

A feature of the book is that each chapter is, in general, complete in itself whilst the historical approach permits the use of extensive basic literature references, a total of approximately 1500 references being given. Early chapters provide production and consumption statistics for the industry and review the economics of benzole recovery. Processes for the production of benzole from the carbonization of coal are fully described and include details of the method and theory of directed carbonization in coke ovens.

Attention is drawn to the similarity between the secondary high temperature reactions of naphthenes in high temperature carbonization and the reactions occurring in the catalytic process employed in the petroleum industry to form aromatics.

There follows a chapter devoted to the production of aromatic hydrocarbons from petroleum and giving a survey of the commercial cracking and reforming processes.

Oil gasification processes and the products arising therefrom, because of their closeness to the gas industry, are described in considerable detail. An unsatisfactory ratio between the price received for coke and paid for coal may force the gas industry in the direction of complete gasification coal oil plants.

Basic distillation theory with further suggestions for reading introduces a section on distillation plant used by the benzole industry with notes on still column and heat exchange design. Similar treatment is given to benzole recovery by oil washing, and 135 pages are devoted to the

function, design, and operation of recovery plant. An unusual amount of information on operating detail, with case histories and difficulties arising in works practice, is provided, together with a description of the function and desirable characteristics of various types of wash oils, including petroleum oils.

Whilst the authors consider that a complete definition of the vast amount of material dealing with the practice and theory of adsorption processes is outside the scope of the book, they have nevertheless been able to condense this material to form a sound introduction to a survey of the plant and processes employed in the recovery of benzene from coal gas in the U.K. and on the Continent. Details are given also of recovery methods using refrigeration and compression, and although these find little application in the U.K., being uneconomic for benzole recovery at the present time, it is stated that the occurrence of a gas grid system with high pressure distribution may necessitate a review.

In recent years the development of new and improved analytical methods has permitted a much more comprehensive study of the constituents of crude benzoles than has been made previously, and in a chapter devoted to the subject a description is given of the factors influencing the composition.

The refining of crude benzole occupies a large section of the book, the removal of carbon disulphide by defronting and extraction being fully described. Following extensive development in the petroleum industry, use is now being made of catalytic hydrofining methods in the coal tar industry. However, since the previous edition, much work has been done on the theory and practice of sulphuric acid washing, and the conclusions drawn are a valuable guide to the producer in securing optimum refining results by this method. Information is given on the disposal of acid tar and effluents, and the legal aspects of this problem are well covered. Among other refining processes described are fractional distillation, solvent extraction, and crystallization.

The authors have dealt with the formidable subject of instrumentation by reviewing the basic principles involved, by presenting examples of control systems in typical plants used in the industry, and by providing an extensive bibliography for further reading.

The section describing the properties of benzole and its constituents, 130 pages with 340 references, provides a very valuable source of collected data, much of it in tabular form. The chapter does not refer to the chemistry of the aromatic hydrocarbons, this being covered under the heading "Industrial Uses of Benzole," where a very readable summary of the development and application of the coal tar hydrocarbons as chemical raw materials is given. In view of the uses of the hydrocarbons in the surface coating industry, it may be considered an omission that reference is not made to solvent parameters when surveying the fundamental properties.

The use of benzole as a motor fuel is reviewed from the aspect of the benzole producers and marketers, but the conclusions drawn, which emphasize its value in the present motor spirit market, are the outcome of theoretical considerations supported by experimental data to which full reference is made.

In chapters dealing with specifications, tests, and methods of analysis of the coal tar light hydrocarbons, information is given on the requirements for the major producing countries throughout the world. Only summaries of the methods are given, since they are fully described in the related handbooks to which attention is drawn. Of equal or greater importance is the significance of the tests and the full explanations given are an excellent feature.

A full name and subject index is provided and careful proof reading has ensured an almost complete absence of errors. The mounting production of benzene and aromatic hydrocarbons from the coal tar and petroleum industries, designed to satisfy the increasing demand from the chemical industries, has emphasized the need for up to-date information of the widest scope. The National Benzole and Allied Products Association has met this need in publishing a volume which should be on the shelves of all who are interested in the technology of benzole, either as producers or users.

A. J. G.

Industrial Editing. Bernard Smith. London: Pitman, 1961. Pp. xi + 225. 27*s*. 6*d*.

This book was written at the request of the British Association of Industrial Editors, of which the author is a founder member and one-time chairman. It is the first full-length book on this subject published outside the U.S.A.

The author writes from considerable experience, since he was for some years editor of the *Shell Magazine*—the house journal of the Shell Group.

House journals are classified by the author into three groups—the "internal" for employees, the external, covering a wide variety of readerships, and the dual-purpose house journal, intended to be read both within and outside the organization which publishes it.

The internal house magazine should be a potent aid to good staff relations, and by presenting a news service about the employees themselves it makes them realize that they are individuals in whom the company takes an interest. It can also serve a useful purpose in explaining personnel policies and amplifying, where necessary, official pronouncements. By reporting on current activities it keeps its readers abreast of company affairs, while its recording of employees' own activities lets them know what their colleagues are doing.

It is a good medium for giving the staff information about company structure and organization and for publicizing the financial results of the year's work. In addition, it should contain articles of general interest, preferably written by the staff themselves.

Internal house journals outnumber the "external" in the U.K. by about four to one. They are a fairly homogeneous class of publication so far as their purpose and policy are concerned. The same cannot be said of external house journals, since the purposes for which they are published are many and various, and equally so are the classes of reader to whom they are designed to appeal.

It is important to decide to whom an external magazine is directed, the dealer or retailer, the customer, the shareholder, the scientist and technician, or the public at large. Ideally there should be a separate journal for each of these classes, but in practice this is rarely possible. There are two important types of external journal, those devoted to sales promotion and those devoted to public relations.

The sales promotion journal has a very simple objective, to persuade the reader to buy the company's products. This it attempts to do by arousing his interest and by showing him the benefits he will obtain by so doing. For this reason the subject matter will be closely related to the company's activities.

The object of the public relations magazine is somewhat different. Its primary aim is not to increase sales but to present a picture of the company and its relationship with the industry of which it forms a part. Here again the approach will depend on the particular section of the public to whom the journal is addressed.

There is another type of "external" which falls somewhere between these two, and that is the journal designed for the technical or scientific reader. A journal of this kind will have a wider range of subject matter, for it will extend

to all aspects of the industry concerned. It will deal with problems of application and of future development.

An organization which has limited facilities may have to content itself with one house journal only, and will wish this to cover the functions both of the "internal" and the "external." It is not possible to do this adequately, and the "dual-purpose" journal is at best a compromise. It often starts as a staff magazine and if successful is made to cover public relations as well. However, the attempt to deal with internal staff activities and to include matter of interest to the outside reader may end in producing something which satisfies nobody.

The author devotes a lot of space to discussing the attributes required of the editor of a house journal. In the U.K. the editor often takes the job without having any previous training; he probably has other work to do and runs the journal as a spare-time occupation. This is seldom the case in the U.S.A. where the editor has usually taken a specialized course in journalism at a university. The author is emphatic that editorship of a house journal should be a full-time job if the magazine is to be worthy of the organization. He suggests that when an editorial vacancy has to be filled it is preferable to appoint an employee who has shown some aptitude for this type of work. He must have writing ability and a feeling for words; he must not be afraid of hard work, and he must have sound judgment, which he must be able to exercise quickly. He must have initiative and be a good mixer.

The editor's relationship with his management has a profound influence on his work. He needs his management's support and guidance, but he must be given his full share of responsibility in running the journal and must be recognized as someone who is doing a specialized and important job.

One chapter in this book is devoted to "Printing and Blockmaking." The information on the various printing processes is probably adequate for the reader for whom this was written, *i.e.* the editor and assistant editor, but the reviewer as a layman must confess that he was puzzled in some places and needed more and simpler information. There is a plate showing some examples of half-tone screens with comments on the correctness of the screens used. The reviewer could not in all cases understand the author's comments on these examples.

In a chapter on "Design and Layout" the author discusses the pros and cons of the newspaper format as against the magazine, and decides that the choice must be guided by the motive of the house journal's contents and by the tastes of its readers. He gives useful information on the different types available and deals with the place of illustrations in a house journal.

Finally, the work of the editor between issues is considered, and a number of matters, such as distribution, the question of charging, dealing with complaints, etc., are covered.

There are three appendixes, one on "The House Journal Editor and the Law," the second a glossary of technical terms, and the third, some information on the British Association of Industrial Editors.

This book is, as one would expect, very well and lucidly written. It contains much valuable information and should be read by all those with a house journal to run. It also makes most interesting reading even for those without such a responsibility. It is beautifully printed and illustrated. At present-day prices it is very good value for money.

D. L. S.

Flexural Vibrations of Rotating Shafts. F. M. Dimentberg. London: Butterworths Scientific Publications, 1961. Pp. ix + 243. 60*s*.

The author gives the results of his investigations in recent years into the basic problems of transverse vibration relating directly to the design and calculation of stress in high-speed shafts.

Certain basic general propositions are first established. With advanced mathematical techniques, including the use of the dynamic rigidity method with complex notation involving a rotating system of co-ordinates, the author establishes and analyses, mainly from a qualitative aspect, the factors relating to shaft vibration under a variety of conditions approximating to those encountered in practical shafts.

The analysis of the stresses in a shaft system during transition through the critical speeds allowing for friction internal and external to the shaft, the effect of anisotropic elasticity in bearings, forced and natural vibrations and stability of shafts with dissimilar moments of inertia in cross-section, coupled rotors in heavy resilient bearings, distributed gyroscopic effects, and the influence of shear deformation are some of the aspects covered in this detailed, competent, and comprehensive analysis. The theoretical conclusions are supported by test data from actual turbine rotors and experimental models.

The book is a lucid translation from the original Russian text, and contains a bibliography of relevant works, mainly from Russian, but also from European and American sources.

With the steadily increasing use in industry of higher speeds and powers in centrifugal and turbo machines, this book is welcome for its attempt to clarify some of the problems of behaviour of rotating shafts which have not previously been fully examined. It is a mathematical treatise on the subject, and no concession is made to the engineer, who prefers where possible to avoid the use of the calculus. Its real interest and value will therefore tend to be limited to the specialist student, designer, or research worker on the subject.

T. E. P.

Gases at High Densities and Temperatures. Yu. N. Ryabinin. Oxford, London, New York, Paris: Pergamon Press, 1961. Pp. vii + 52. 25*s*.

This 52-page monograph, after a brief historical review of past researches into the high-pressure properties of gases, is devoted to a description of original researches at the Institute for Chemical Physics, U.S.S.R. Academy of Sciences.

The apparatus used in these investigations subjects a test gas (187·5 cm^3) to a rapid isentropic compression in a closed cylindrical tube (25·62 mm diameter, 365 mm length) by means of a well-fitting piston accelerated by a driver gas. Gas pressures up to 10,000 kg/cm^2 were achieved in compression times of 10 msec, the piston speed lying in the range 30–50 m/sec. Maximum pressures of the test gas were measured by means of a mechanical pressure gauge in the form of an indentation accelerometer placed inside the piston.

The light emission from gases compressed isentropically thus to very high temperatures and pressures was studied in the ultra-violet and visible regions. No radiations were recorded with the polyatomic gases CO_2 and CH_4 when compressed to 10,000 kg/cm^2, at which pressure the CO_2, for example, was 1·42 times as dense as water. Diatomic and especially monatomic gases, which became much hotter upon compression, on the other hand, gave rise to some interesting spectra which were studied carefully, and in one case with time resolution. Nitrogen, air, and industrial argon were investigated, temperatures up to 3000° K occurring with the first two gases and up to 9000° K with the argon. The extensive radiations emitted in the latter case were due to the excitation of N_2, OH, and NO derived from the impurities.

Electrical conductivities were also measured; it was found by comparison with the Saha equation that air behaves according to its expected nitric oxide content (when compressed) in so far as its ionization properties are concerned. Timan's theoretical ionization equilibrium for a non-ideal gas allowing for the effect of intermolecular forces at high temperatures and densities was substantiated by the experiments.

It was concluded that in the isentropic compression experiments industrial argon behaves much like the ideal gas of the same composition ($PV/RT \approx 1$). This result does not conflict with Bridgeman's earlier finding that $PV/RT \approx 5$ as Ryabinin's experiments at the corresponding pressure of 4750 kg/cm² produced gas at a 23·5 times higher temperature and 4·6 times lower density.

This monograph is easy to read, contains 79 references and a moderate amount of new and interesting data, and can certainly be recommended to physics undergraduates and research scientists and engineers interested in the isentropic compression of gases. B. P. M.

Surface Activity. Second edition. J. L. Moilliet, B. Collie, and W. Black. London: E. & F. N. Spon, 1961. Pp. xvi + 518. 75*s*.

The growth of the science of surface activity gives a good example of the explosive increase in the amount of scientific knowledge becoming available in the past decade. A critical appraisal of new developments in this field and a balanced survey of the science in the light of these developments is invaluable to all those who are connected with uses or manufacture of surface active agents. This includes, of course, many petroleum technologists.

" Surface Activity " goes a long way towards giving such an up-to-date treatment of the subject. The first part of the book deals with physical chemistry of solutions of surfactants. The treatment includes micelle formation and properties (mainly in aqueous solutions), thermodynamics of adsorption of surface active agents, kinetics of adsorption, and fundamental interfacial processes such as wetting phenomena and phase sub-division. An essentially classical thermodynamic treatment is given, starting with Gibbs adsorption isotherm and including the work of Guggenheim. Adsorption is regarded as a process involving solutes dissolved in inert media, and no consideration is given to competitive or preferential adsorption of different solutes or, indeed, of the solutes and solvent.

The authors give a very interesting account of the solid/liquid interface, which includes the effect of surfactants on the mechanical properties of solids. There are also interesting discussions of concentration effects on adsorption at solid/liquid and liquid/liquid interfaces, effect of surfactants on sub-division of solid phases, and nucleation processes. In the treatment the authors provide valuable critical appraisal of the material presented at the Second International Congress of Surface Activity (London, 1957).

The part of the book dealing with technical applications of surface active agents is somewhat influenced by the authors' background of dyestuffs and related industries. Thus, for example, surfactant applications as dyeing assistants and stripping agents are discussed, whilst little space is devoted to non-aqueous solutions of surface active agents and no mention is made of their use in the formulation of modern lubricating oils and additives. However, the lack of discussion of applications of surface active agents in petroleum technology constitutes one of the very few omissions. The authors give very competent and balanced accounts of wetting out processes, emulsions, dispersion of solids, and detergency.

The section of the book on the chemistry of synthetic surface active agents provides an excellent summary of a large amount of published information widely scattered in technical journals and patents, and covering most of the advances that were made up to 1960.

It is certainly very instructive and stimulating to read and study this up-to-date work on surface activity, and the book can be recommended to all petroleum technologists interested in the subject. A. G.

J. Paul Getty. Ralph Hewins. London: Sidgwick & Jackson, 1961. Pp. 300. 25*s*.

Primarily an oilman, Paul Getty's activities have been and still are spread over many diverse spheres. Thus, apart from the Getty, Skelly, and Tidewater concerns, which have a market value of the order of a thousand million dollars, Getty played a large part in the manufacture of aircraft during the second world war, and he still has a substantial interest in Spartan aircraft, which incidentally is now active in the manufacture of mobile homes. A hotel in New York and one in Mexico also figure in his balance sheet.

The subsidiary title to this biography describes Paul Getty as " The Richest American," and it is shown that, whatever his financial resources, his net reserves in crude oil at the time of writing were 10,177 million barrels, with an additional 15 billion barrels in shale oil reserves near Rifle, Colorado. The crude oil reserves are probably considerably underestimated, as it is stated later in the book that his reserves in the Neutral Zone " have only recently been proved at the astronomical but conservative figure of about 10,000 million barrels."

Paul Getty's first entry into the oil business was due to a casual investment of $500 by his father in 1903 in a 1100-acre lot in Indian territory and the formation of the Minnehoma Oil Company. Paul bought 100 shares in the company for $5 early in 1904. Lot 50, as it was known, soon proved its worth, and from 1903 to 1915 netted $326,000, being sold in 1916 for $120,000 cash. From then on his interest in oil was paramount and, except for a comparatively brief period given up to pleasure, has remained so.

He has had considerable practical experience in the technicalities of the industry, and his diary records the shooting of a well on Lot 50 in 1904 with 100 quarts of nitroglycerine. In 1910–11 he was working as a roustabout and tool dresser, and in 1927, when George F. Getty Inc were having trouble with a side-tracking job, he collected a granite shift from the local cemetery and cut one end to a taper, to produce a granite whipstock. This " Paul Getty Special " was successful and gave no trouble in use for many years. It is also recorded that Paul Getty was instrumental in the development in 1947 of the drilling of horizontal holes, using flexible curved tubing driven by the mud pumps.

Throughout the book there is the impression of a man who was always one step ahead. Thus, when Tidewater completed its Wilmington refinery in 1957, it was considered to be ten to 15 years ahead of any refinery in existence and was fully automated. And so with tanker construction. By bold forward planning he was taking delivery of vessels in 1956–57 at $100 a deadweight ton at a time when the current price was $250. Even in 1958, when costs were $150 per deadweight ton, he was obtaining delivery of supertankers at one-third of that price.

The author has dealt with his subject in a series of more or less individual chapters, each discussing a separate feature of the life, activities, and make-up of this remarkable man—a man who seems to have been almost everything. One poignant chapter is headed " Tragedy," the tragedy of a man five times divorced, who said: " I blame my business interest for having been married five times."

In his concluding chapter " The Future," the author

writes: "But still he is full of aggression, expansion, and new ideas. He is uranium." G. S.

Die Geologie Mittelamerikas. R. Weyl. Pp. xv + 226. Berlin: Gebrüder Borntraeger, 1961.

Almost 30 years after the publication of the well-known and comprehensive books on the geology of Central America by Schuchert and Sapper a new book dealing with this subject has appeared. It is the first volume in a series of publications on the regional geology of the earth, edited by Prof A. Bentz.

The author of "Die Geologie Mittelamerikas," Richard Weyl, is Professor of Geology and Palæontology at the University of Gießen. Having spent several years in Central America, he has contributed considerably to the knowledge of the geology of this part of the world during the past ten years.

The book is divided into seven chapters. The introduction into the geography is followed by two chapters treating the general geology of the area in great detail. The stratigraphy is described in historical sequence. The author considers the historical development of Central America in terms of its two major structural units.

Northern Central America has been subjected to strong Palæozoic folding and metamorphism, with a subsequent partial geosynclinal rejuvenation during Mesozoic times. The last, mainly germanotypic folding, took place at the end of the Cretaceous. Southern Central America has been folded during Middle Tertiary following a preceding geosynclinal period comprising part of the Mesozoic.

One chapter is exclusively devoted to the enormous volcanic activity. The close relationship between intrusive and extrusive magmatism during the Tertiary is emphasized. The data on the Tertiary volcanism are especially valuable, as comparatively little has been known on this subject. The intensive sialic magmatic activity is to a great extent represented by felsic lava and appears to belong to the post-orogenic type. It is an interesting fact that in Central America this magmatism is apparently not a direct consequence of one major orogenic phase. This refers especially to Northern Central America, with its strong magmatic activity, particularly during the Tertiary. The missing major orogeny seems to be substituted by magmatism, rendering the general problem of the origin of the magma during this geotectonic stage even more complicated.

Many new chemical analyses have been included, allowing a revision of the petrological nomenclature according to a uniform scheme.

Earthquakes and recent mobility in Central America, as well as its mineral resources, are treated adequately.

The author has not only incorporated all published data but also much unpublished material contributed by several sources. The book is furnished with many geological maps on folders, sections, and diagrams, which add substantially to the understanding and perfection of the volume.

It is not necessary to recommend this book to all those interested in the geology of Central America. Being the most modern and excellently edited compilation, it is bound to become the leading reference work on the geology of Central America for many years. A. L.

ADDITIONS TO THE LIBRARY

Entries are in subject order arranged according to the Uren "Classification for Petroleum Bibliography," the number preceding each entry indicating the classification and corresponding to that used in the "Library Catalogue" published by the Institute.

094 British Standards Institution. Methods for notched bar tests. Part 1. The Izod Impact Test on Metals. London, BSI, 1961. 22 p. (BS 131 : Part 1 : 1961.)

094 British Standards Institution. Specification for internal combustion engines spark ignition type. London, BSI, 1961. 21 p. (BS 765 : 1961.)

094 British Standards Institution. Specification for bolting for the petroleum industry. London, BSI, 1961. 16 p. (BS 1750 : 1961.)

094 British Standards Institution. Specification for metallic spiral-wound gaskets for the petroleum and petrochemical industry. London, BSI, 1961. 6 p. (BS 3381 : 1961.)

094 British Standards Institution. Specification for electroplated coatings on threaded components. Part 1. Cadmium on steel components. Part 2. Zinc on steel components. London, BSI, 1961. 32 p. (BS 3382 : 1961.)

094 British Standards Institution. Specification for forks, shovels, and spades. Part 1. General purpose tools. London, BSI, 1961. 61 p. (BS 3388 : Part 1 : 1961.)

094 Indian Standards Institution. Specification for kerosines. New Delhi, ISI, 1960. 5 p. (IS : 1459—1959.)

094 Indian Standards Institution. Specification for diesel fuels. New Delhi, ISI, 1960. 5 p. (IS : 1460—1959.)

094 Indian Standards Institution. Method for gauging of petroleum and liquid petroleum products. New Delhi, ISI, 1961. 50 p. (IS : 1518—1960.)

094 Indian Standards Institution. Specification for vaporizing oil. New Delhi. ISI, 1960. 4 p. (IS : 1558—1960.)

094 Indian Standards Institution. Specification for aviation turbine fuels, kerosine type. New Delhi, ISI, 1960. 7 p. (IS : 1571—1960.)

094 Indian Standards Institution. Specification for aviation turbine fuels, high flash point type. New Delhi. ISI, 1960. 7 p. (IS : 1587—1960.)

094 Indian Standards Institution. Specification for aviation turbine fuels, wide cut gasoline type. New Delhi, ISI, 1960. 7 p. (IS : 1588—1960.)

094 Indian Standards Institution. Specification for oil, cylinder. New Delhi, ISI, 1960. 9 p. (IS : 1589—1960.)

094 Indian Standards Institution. Specification for fuel oils. New Delhi, ISI, 1960. 9 p. (IS : 1593—1960.)

094 Indian Standards Institution. Specification for aviation gasoline. New Delhi, ISI, 1960. 8 p. (IS : 1604—1960.)

094 Indian Standards Institution. Specification for oil, lubricating, axle, regular and premium. New Delhi, ISI, 1960. 7 p. (IS : 1628—1960.)